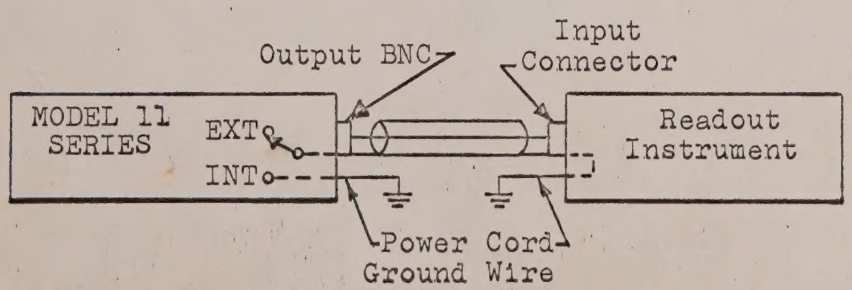
I M P O R T A N T

GROUNDING PROCEDURES

1. An INTERNAL-EXTERNAL Ground Switch is provided at the rear of the Series 11 instrument to permit the best selection of grounding conditions. With the Ground Switch in the EXTERNAL position, the Series 11 signal ground is floating (electrically isolated from the chassis.). With the Ground Switch in the INTERNAL position, the Series 11 signal ground is connected directly to the chassis.

2. The INTERNAL position must be used when the 3 prong power plug is not connected to ground through the power outlet. The INTERNAL position must also be used when the signal output is not connected to ground through the readout instrumentation. If the chassis and signal grounds are not connected together, either at the instrument or in the system installation, 60 Hz hum will appear on the signal output.

3. The EXTERNAL position may be used when chassis ground and signal ground are connected through the external system connections. In many cases, the chassis is connected to ground through the power cord ground wire, and the signal ground connection is completed through the readout instrumentation. This arrangement is shown in the diagram below. A grounding procedure of this type provides system grounding at one point and normally minimizes unwanted ground signals. With a more complex system ground condition, the most favorable position of the Series 11 INTERNAL-EXTERNAL Ground Switch should be determined by checking both switch positions while observing system ground loop conditions on an oscilloscope.



SPECIAL DIFFERENTIAL FEATURE - MODEL D11 SERIES

A front panel switch provides dual mode operation for use with grounded accelerometers (ACCEL GND) or isolated accelerometers (ACCEL FLOAT). In the ACCEL GND mode, the Model D11 Series rejects the ground loop signal that would normally be created when the accelerometer is grounded. The Model D11 suppresses the ground loop by providing electrical isolation between the input circuit ground and the output circuit ground. A rejection factor in the order of 1,000 or more is provided when operating in the ACCEL GND mode for accelerometer ground potentials that differ by as much as 500 mV rms from the output circuit ground potential. This electrical isolation of ground potentials eliminates the need for providing mechanical means of ground isolation. Mechanical means are undesirable because they involve additional expenses and introduce known or unexpected problems relating to dynamic response characteristics and reliability.

The front panel pilot light serves as an indicator of proper operation of the FLOAT/GND mode switch. The light remains on when the input circuit ground is grounded at the accelerometer and the mode switch is in the ACCEL GND position. If the accelerometer is ungrounded when the mode switch is in the ACCEL GND position, the pilot light will turn off and indicate that the mode switch should be placed in the ACCEL FLOAT position.

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DIFFERENTIAL CHARGE/VOLTAGE AMPLIFIER

MODEL D11MGSV

- Operates with grounded accelerometer without the usual ground loop problems
- Differential circuitry rejects common mode signals
- Eliminates need for costly and unreliable isolating studs
- Pilot light indicates whether the accelerometer is grounded or floating
- Switchable operation as either a charge or voltage amplifier
- Grounded accelerometer can be used in either the charge or voltage modes
- High impedance input provided by remote Model 11PA-2 impedance converter (line driver) in voltage mode of operation

GENERAL DESCRIPTION

The Model D11 Series features differential type circuitry that provides common mode rejection of the ground loop signals that are normally created when the accelerometer is grounded. Isolated power supplies for the input and output circuits permit connection of the instrument input to a ground potential that is different than that of the readout instrumentation. For a typical test fixture grounding condition, rejection of the ground loop signal by a factor of 1,000 or more is provided when operating with the most sensitive gain settings. This results in instrumentation system noise levels that are essentially the same with grounded accelerometers as when isolating techniques are used.

Isolating studs are often undesirable because they can be cracked by overtorquing and yield unreliable data. Isolating techniques also involve added costs and create mounting problems when accelerometers must be located in tight places.

The switchable CHARGE/VOLTAGE feature of the Model D11MGSV allows this instrument to be used with both "charge" and "voltage" type piezoelectric transducers. This instrument is suitable for making measurements with dynamic strain gages, and is compatible with both high and low impedance sources. In the CHARGE

mode with 1,000 pF source capacitance, the noise referred to the input is less than .005 pC rms. When the ultra low noise CHARGE amplifier is used with a series 1,000 pF capacitor (V-CAL mode) for low impedance dynamic strain gage measurements, the noise referred to the input is less than 5 μV rms.

When the instrument is switched to the VOLTAGE mode for operation with the remote Model 11PA-2 impedance converter, the noise level is less than 40 μV rms, independent of cable length between the remote Model 11PA-2 line driver and the rack mounted Model D11MGSV. The input resistance of the Model 11PA-2 is 1,000 Megohm, and the output impedance is less than 50 ohms. The Model 11PA-2 is capable of driving up to 2,000 ft. of standard RG/U coaxial cable without loading effects. The Model D11MGSV full scale range and sensitivity controls apply to both the CHARGE and VOLTAGE modes of operation.

SPECIFICATIONS FOR "D" AND "V" FEATURES

(See Model 11 Series Charge Amplifier Bulletin for Basic Performance)

FLOAT/GND Switch: Two position toggle switch to select amplifier operation with "Floating Accelerometers" or "Grounded Accelerometers".

GND Mode: Common mode rejection of 1,000 or more for 500 mV ground potentials between input and output circuits for most sensitive gain settings of instrument.

Accelerometer Ground Indicator: Pilot light indicates whether the accelerometer is grounded or isolated when the GND mode is selected.

CHARGE/VOLTAGE Switch: Selects the CHARGE mode for operation with piezoelectric type transducers and the VOLTAGE mode for operation with the remote Model 11PA-2 impedance converter (line driver).

Controls: All full scale range and sensitivity controls maintain accuracy within ±1/2% for changes between CHARGE and VOLTAGE modes of operation.

Input Connectors: CHARGE INPUT – BNC
11PA-2 VOLTAGE INPUT – Phone Jack. (Mating phone plug is two-conductor Switchcraft type 280 or equal).

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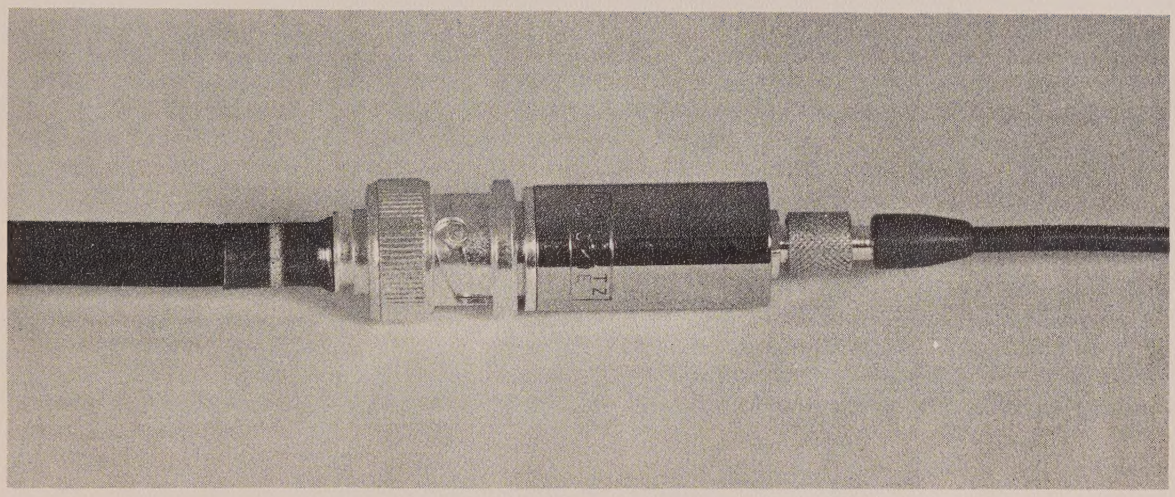
vibration generation systems and measurement instruments



MODEL 11PA-2 REMOTE PREAMPLIFIER

The Model 11PA-2 is a low cost remote impedance converter that is designed for use with the Model 11 Series Instruments. The 11PA-2 is packaged as a BNC to Microdot adapter type unit, and uses standard RG/U type coaxial cable between it and the Model 11 Instrument. The 11PA-2 features a high input impedance, low output impedance capable of driving up to 2000 ft. of standard RG/U cable without cable load effects, and obtains its power directly from the Model 11 Instrument.

Specifications:

Voltage Gain:	1.0
Input Impedance:	1000 Meg shunted by 6 pF
Output Impedance:	Less than 50 ohms
Output Voltage:	10 volts peak
Output Current:	5 mA peak
Frequency Response:	±2% from 1 Hz to 50 kHz when driven from 1000 pF source capacitance
Noise:	40 microvolts rms

Physical:

Input Connector	–	Microdot
Output Connector	–	BNC
Dimensions	–	1½ long x 1/2 diameter

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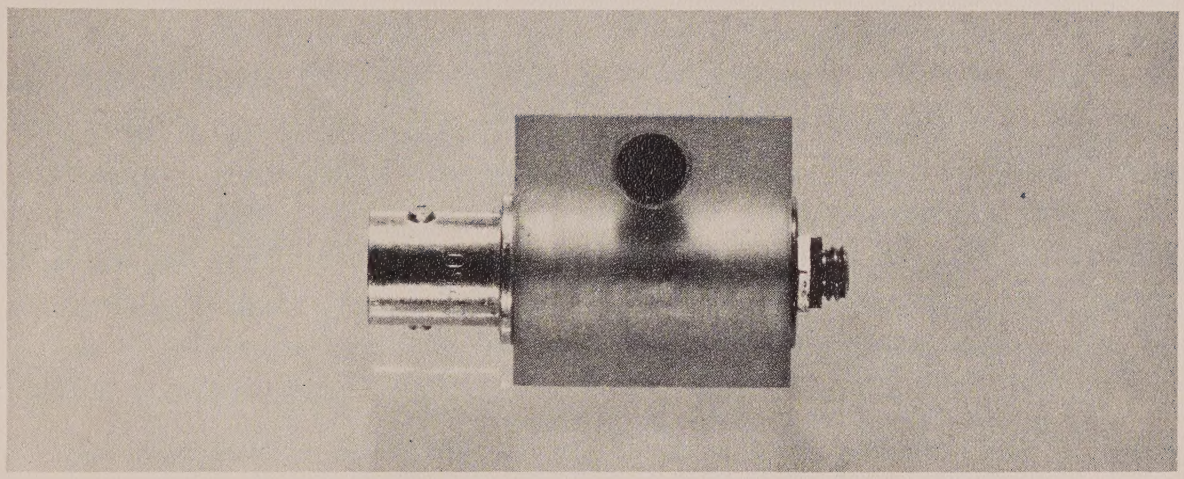

MODEL 11CA-2 REMOTE CHARGE AMPLIFIER
(Cylindrical type with insulated mounting block shown)

The Model 11CA-2 is a low-cost remote charge amplifier designed for use with the Model 11 Series Instruments. The 11CA-2 is packaged with a Microdot input and a BNC output, and uses standard RG/U coaxial cable between the output and the Model 11 Instrument. The 11CA-2 features insensitivity to input cable length, low noise, and capability of driving 2000 ft of RG/U cable without cable load effects. The power is obtained from the Model 11 Instrument.

Performance Specifications:	
Conversion Gain:	1 mV/pC
Input Impedance:	At least 0.5 μF shunted by 22 megohms
Output Impedance:	Less than 50 ohms
Effect of Source Capacitance on Gain:	Gain change less than 1% for source capacitance up to 5000 pF
Output Voltage:	10 volts peak
Output Current:	3 mA
Frequency Response:	±2% 1 Hz to 50 kHz when driven through 1000 pF source capacitance
Noise:	.005 pC rms ± .002 pC rms/1000 pF source capacitance, referred to the input
Physical Description:	
Input Connector:	Microdot
Output Connector:	BNC
Dimensions:	1 3/4 long x 11/16 diameter (bulkhead mount)
	1 5/8 long x 11/16 diameter (cylindrical)
Insulated Mounting Block:	1 x 7/8 x 7/8 (supplied with cylindrical unit)

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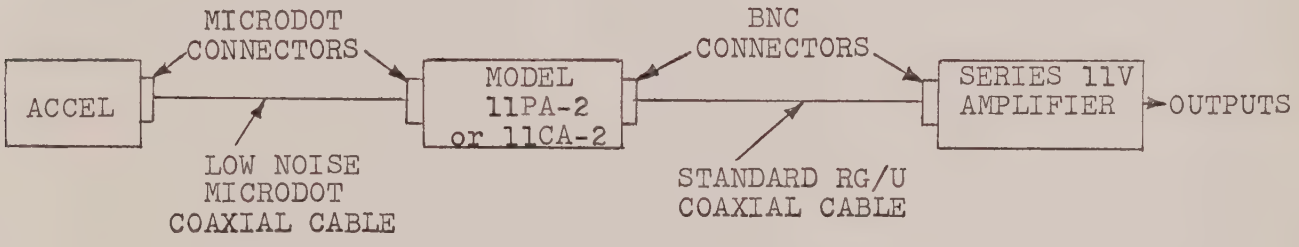
SPECIAL REMOTE PREAMP FEATURE - SERIES 11V AMPLIFIER

The Series 11V Amplifier is designed for operation as either a conventional, self-contained, charge amplifier or as a special voltage type amplifier that is used with the remote Model 11PA-2 voltage preamp or the remote Model 11CA-2 charge preamp. The rear panel C/V Switch selects the local charge mode, "C", or the remote preamp mode, "V". The connection to the remote preamplifier is by a standard RG/U type coaxial cable as shown below. The output impedance of the remote preamp is very low so there is negligible sensitivity of this cable to electrical pickup and mechanical motion. The coaxial cable to the remote preamp is connected to the rear mounted Series 11V phone jack labeled PREAMP. When in the "V" mode of operation, power is supplied to the remote preamp from the Series 11V Amplifier.

The performance characteristics of the remote Model 11PA-2 voltage type preamp are described in Bulletin 11PA-2-11-67.

The performance characteristics of the remote Model 11CA-2 charge type preamp are described in Bulletin 11CA-2-68.

When the Series 11V Amplifier is in the "V" mode of operation, the Sensitivity Dial calibration is in terms of mV/g, or pC/g as determined by the type of remote preamp used.



It should be noted that the calibration features of TEST, V-CAL and F-CAL do not apply when the remote preamp is used. Calibration with the Model 11PA-2 voltage type preamp is accomplished by connecting the calibration voltage source directly to the input of the Model 11PA-2 with the TVNF mode switch in the NORM position. Calibration with the Model 11CA-2 charge type preamp is accomplished by connecting the calibration voltage source through a Series 1000 pF $\pm$ $\frac{1}{4}$% capacitor to the input of the Model 11CA-2 with the TVNF mode switch in the NORM position.

An insulated mounting block is supplied with each remote preamp to

permit attachment to a fixed object in the vicinity of the test item. A 3/4 inch 6-32 screw is suggested for normal mounting.

When the transducer is connected to the Model 11CA-2 charge type preamp, the transducer sensitivity in pC/g is used. For option I units, with 1 mV/pC conversion gain, the gain accuracy changes less than 1% for 5,000 pF source capacitance. For option III units, with 10 mV/pC conversion gain, the gain accuracy changes less than 1% for 500 pF source capacitance.

When the transducer is connected to the Model 11PA-2 voltage type preamp, the transducer sensitivity is determined in mV/g for the cable capacitance involved. The proper voltage sensitivity is determined from the relationship:

$$Q = CV \quad \text{or} \quad V = \frac{Q}{C}$$

where Q = piezoelectric transducer charge sensitivity

C = total capacitance of transducer, cable and Model 11PA-2 input

V = voltage sensitivity of loaded transducer

The units are volts, coulombs, and farads. A typical example is with the Unholtz-Dickie Model 75D21 accelerometer and 10 feet of Microdot cable between the accelerometer and Model 11PA-2 line driver.

$Q = 70$ pC/g

$C_{ACCEL} = 1000$ pF

$C_{CABLE} = 300$ pF

$C_{INPUT} = 6$ pF

$$V = \frac{70 \times 10^{-12} \text{ coulombs/g}}{1306 \times 10^{-12} \text{ farads}} = 53.5 \times 10^{-3} \text{ volts/g} = 53.5 \text{ mV/g}$$

The voltage sensitivity is dialed in at the front panel Sensitivity Dial.

OPERATING AND SERVICING INSTRUCTIONS

UNHOLTZ-DICKIE

Model D11MGV

CHARGE AMPLIFIER

Signal-Conditioning Instrument

Unholtz-Dickie Corporation
2994 Whitney Avenue
Hamden, Connecticut 06518

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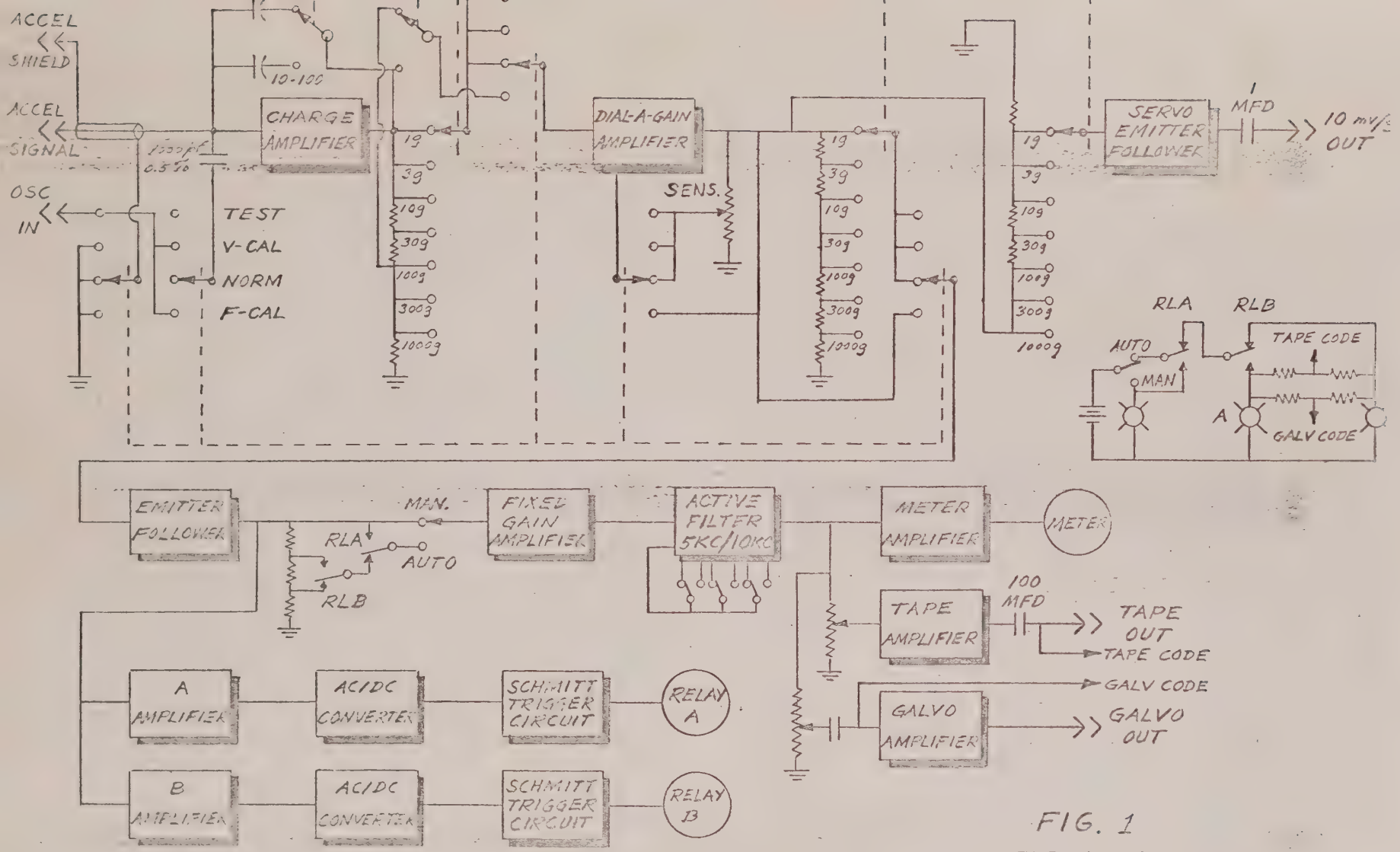


FIG. 1

BLOCK DIAGRAM

UNHOLTZ-DICKIE MODEL 11 MGSA

CHARGE AMPLIFIER

GENERAL DESCRIPTION

1. Introduction - Description of Operation

The Model 11 Charge Amplifier is a modular, low-noise, solid-state, data-acquisition instrument, with self-contained power supplies. Six of these may be mounted in a Model 11R frame which is suitable for rack mounting.

The basic instrument accepts an input from a transducer with capacitive output impedance and has a variable-gain, range-switched output suitable for tape recording. Options include an indicating meter (suffix M), a normalized 10mv/g "servo" output (suffix S), and a variable-gain output suitable for galvanometer recording (suffix G). Also available is automatic selection of the best-of-three adjacent full-scale ranges (suffix A), or a logarithmic output for the tape, galvanometer and meter circuits (suffix L). The basic instrument also contains a built-in low-pass filter with two cutoff frequencies, and provisions for three calibration modes. An internal calibration oscillator is optional.

The Model 11 features printed circuit construction, and soldered interconnections for reliability. The operation is illustrated by the block diagram in Fig. 1 for the Model 11 MGSA, and is described in further detail in the paragraphs that follow. Figure 2 shows the front panel of the Model 11 MGSA or 11 MGA.

1.1 Charge Preamplifier (Standard)

The charge preamplifier is intended for use with piezoelectric accelerometers, or their equivalent. The charge preamplifier is a wide-bandwidth, high-gain amplifier (approximately 5,000) with capacitive feedback (C_f). The input stage is a high transconductance FET with low-noise characteristics.

Since the input coaxial cables and piezoelectric accelerometers are capacitive (C_c and C_a respectively), the combination of the accelerometer, cables, and charge preamplifier may be analyzed as an operational amplifier. The output voltage of the charge preamplifier (v_o) is given in Eq (1) in terms of the generated voltage at the accelerometer (v_a), the gain of the charge preamplifier (A) and the capacitances.

$$v_o = - \frac{A\, C_a}{C_a + C_c + (1+A) C_f}\, v_a \qquad (1)$$

In terms of the charge generated by the accelerometer (q_A), Eq (1) becomes

$$v_o = - \frac{A}{C_a + C_c (1+A) C_f}\, q_a \qquad (2)$$

Since $(1+A)\,C_f >> C_a + C_c$ Eqs (1) and (2) simplify to

$$v_o \cong -\frac{C_a}{C_f} v_a \qquad (3)$$

$$v_o \cong -\frac{1}{C_f} q_a \qquad (4)$$

Equation (4) virtually explains the nomenclature "charge amplifier."

It is easily seen from Eqs. (1) and (2) that the output voltage, v_o, is virtually insensitive to changes in cable capacitance. For instance, if C_f=1000 pf., A = 5000, and C_c changes from 0 to 50,000 pf., the change in gain is approximately 1%. The over-all gain is approximately 1mv/pC.

Because an increase in source capacitance or cable capacitance lowers the loop gain of the charge preamplifier, the noise referred to the input of the section increases proportionally to the source capacitance. This is reflected in the specifications.

The charge preamplifier is located on one printed-circuit card.

1.2 Dial-A-Gain Amplifier (Standard)

The Dial-A-Gain Amplifier follows the charge preamplifier, and is located on a separate printed circuit card. The gain of this amplifier is varied by adjusting a ten-turn potentiometer in the feedback circuit. The amplifier gain is thus inversely proportional to the turn setting of the gain control potentiometer. When the accelerometer charge sensitivity (in pC/g) is set directly on the dial of the potentiometer, the output voltage of the DAG amplifier is normalized at a constant value in mv/g for any range setting.

The input transistors are selected for their low noise characteristics. For zero source capacitance on the input to the charge amplifier, the output noise of the Model 11 is primarily due to the DAG amplifier. This is reflected in the noise specification.

1.4 Fixed-Gain Amplifier [illegible] and Active Filter

The fixed-gain required to provide the rated peak output voltage is obtained from a 2 stage amplifier with a differential input. The differential amplifier provides a nominal 60 dB common mode rejection when operated in the ACCEL GND (differential) condition. The combined gain of the amplifier and active filter stages is approximately 50. An overdrive capability of 40% beyond full scale output is provided.

The active low-pass filter is a unity-gain device in the pass band. The design is essentially Butterworth, with the frequency response approximately 3 dB down at twice the specified filter frequency, and having less than ± 2% variation at the specified filter frequency. The variation at half the filter frequency is less than ± 1%.

A and B filter frequencies are provided. In the A position, the filter frequency is determined by a set of 3 plug-in capacitors. These capacitors can be selected to provide 1 kHz, 2 kHz, 5 kHz or 10 kHz filter frequencies. In the B position, the filter frequency is "fixed" at any specified filter frequency from 100 Hz to 20 kHz. The "filter out" condition for either the A or B position provides frequency response to 100 kHz. Unless otherwise specified, the A position is supplied as 5 kHz and the B position as 10 kHz.

1.5 Servo Emitter Follower (Option S)

The output of the low-pass filter is applied to a deck on the full scale range switch to maintain a 10 mV/g sensitivity at the Servo emitter follower. The servo output is usable up to 300 g full scale. It is essential that a full scale range position is selected that will handle the highest "g" level to be measured, since clipping occurs at about 40% above the selected full scale output. The servo output impedance is less than 100 ohms and is coupled through a 100 MFD capacitor for operation into 10K ohm loads down to 2 Hz.

1.6 Meter Amplifier (Option M)

The meter amplifier provides the amplification and full-wave rectification necessary to drive the 100 μa meter movement. The meter movement responds to the absolute average value of the input signal and the dial is calibrated in terms the peak value of a sinusoidal input signal.

The meter normally has a dial with a single scale calibrated in per cent of full scale from 0 to 120%. A dial with two scales (0-3, and 0-10) for exactly 10 dB range switching is optional.

1.7 Tape Emitter Follower (Standard)

The tape emitter follower is preceded by a ten-turn potentiometer that allows the full-scale output to be varied from 0 to 5 volts peak. The output is capacitively coupled and capable of providing 1 ma. drive current.

The servo emitter follower, tape emitter follower, and meter circuit are located on the same printed circuit board.

1.8 Galvanometer Driver (Option G)

The galvanometer driver is actually two emitter followers in cascade. The first emitter follower is a NPN stage and the second emitter follower is a PNP stage. The input of the galvanometer driver is capacitively coupled to the arm of a ten-turn potentiometer which allows the maximum output voltage to be continuously adjusted from 0 to 5V peak. The output of the galvanometer driver is direct-coupled.

Positive and negative current limiting at the output is accomplished by supplying the emitters of both emitter-follower stages from constant current sources. The galvanometer driver can provide ± 85 ma. without limiting to loads of 10 Ω and greater.

The galvanometer driver and the associated power supplies are located on a single printed circuit board, with provisions for heat sinking the power transistors.

1.10 Instrument Calibration and Check (Standard)

There are provisions for three types of calibration and checking procedures by means of the MODE switch. The MODE switch has four positions: TEST, V-CAL, NORM., and F-CAL.

In the NORM. position, the ACCEL. input is connected directly to the input of the charge amplifier and the OSC. input is disconnected. This is the situation for normal operation.

In the TEST position the accelerometer shield is connected to the OSC input. The oscillator voltage is fed to the input of the charge preamplifier through the capacitance of the cable and accelerometer. This provides a check of the integrity of the cable and accelerometer.

In the V-CAL position, the OSC input is connected through a 1000 pf $\pm$ 0.5% capacitor to the input of the charge preamplifier. The outputs of the meter circuit, tape emitter follower, and galvanometer driver depend on the sensitivity dial and range switch settings. A voltage of 1 mv at the OSC input is equivalent to 1 pC generated by the accelerometer in this position.

In the F-CAL position, the OSC input is connected through a 1000 pf $\pm$ 0.5% capacitor to the input of the charge preamplifier. The sensitivity dial and range switch are disabled so that an oscillator input signal of 100 mv peak causes full-scale indication on the meter and max. output from the tape and galvanometer circuits.

A direct measure of source capacitance is obtained by measuring the output of the Model 11 in the TEST position and comparing it with the output in the V-CAL position. The external oscillator voltage remains fixed. The source capacitance is

$$C_c+C_a = \frac{V_{TEST}}{V_{V\text{-}CAL}} \quad 1000 \text{ pf} \qquad (5)$$

1.11 Random Operation

When the instrument is used to measure random accelerations, the clipping level should be more than three times the rms value (σ). The meter deflection is proportional to the absolute average value of the input wave. The clipping level for sinusoidal inputs is somewhat above full scale indication. Since for sine measurement

$$|v_s|_{av} = \frac{2}{\pi} V_{s\,pk} \qquad (6)$$

and for random measurement

$$|v_r|_{av} = \frac{1}{3}\sqrt{\frac{2}{\pi}}\, V_{clipping} \qquad (7)$$

Thus,

$$|v_r|_{av} = \frac{1}{3}\sqrt{\frac{2}{\pi}}\,\frac{\pi}{2}\,|v_s|_{av} = .417\,|v_s|_{av} \qquad (8)$$

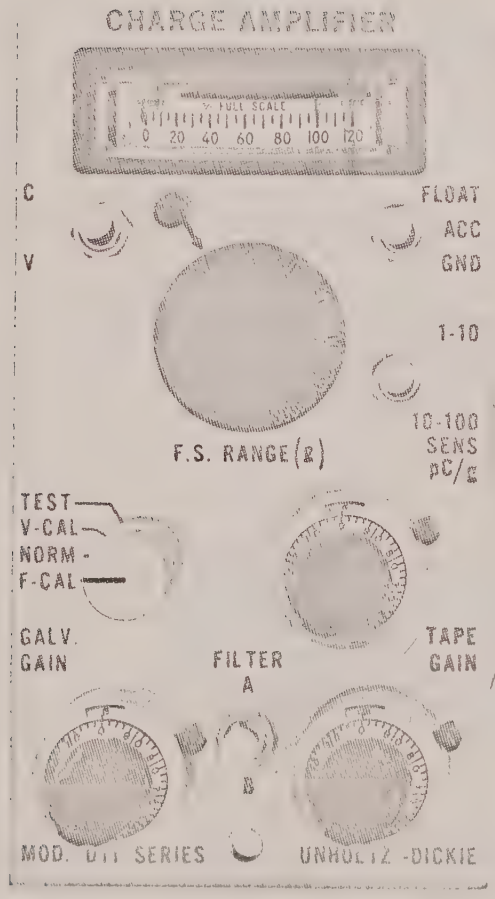


Fig. 2 Front Panel-Model D11MGV

To keep clipping at or above the 3σ level, the scale indicator should be somewhat less than 50% (41.7%) of the indicated full scale value.

In addition, a multiplying factor is necessary to convert the reading to rms acceleration. For random measurement

$$|\sigma|_{av} = \sqrt{\frac{2}{\pi}}\,\sigma \qquad (9)$$

From Eqs. (6) and (9)

$$\sigma = \sqrt{\frac{\pi}{2}}\,\frac{2}{\pi}\,V_{spk} = \sqrt{\frac{2}{\pi}}\,V_{spk} = .8\,V_{spk} \qquad (10)$$

Thus the indicated readings must be multiplied by .8 to yield the rms value of a random waveform.

1.12 Power Supplies - Grounding Provisions

The power supplies for each Model 11 Charge Amplifier are completely contained within the module. The power transformer has two electrostatic shields - one for the primary winding and one for the secondary windings. The shield for the primary winding is connected to the chassis, and the shield for the secondary is attached to signal reference or ground. The ground wire from the power line is connected to the chassis.

Signal ground is electrically isolated from the chassis of the Model 11. To make measurements with the Model 11 and external instruments, the chassis of the Model 11 is usually connected to signal ground by means of the power line ground wire to the chassis and signal ground of the external instruments. The signal cable from the Model 11 to the external instruments completes the path.

In any event, the chassis of the Model 11 must be connected to signal ground, preferably at one point, to prevent 60 Hz hum from appearing on the signal output.

2. Description of Controls

2.1 Module Front Panel Controls - Reference Figure 2

2.1.1 Sensitivity Range Switch - (1-10), (10-100)

This two-position ~~rotary~~ TOGGLE switch establishes the location of the decimal point in the sensitivity number read from the Sensitivity Dial. For shock testing, the full scale range of the instrument can be extended up to 10,000 g by using an accelerometer with a sensitivity in the 1-10 range and placing the Sensitivity Range Switch in the 10-100 range.

2.1.2 Sensitivity Dial

This ten turn dial is calibrated in terms of transducer sensitivity, and is equipped with a locking brake. This dial can be set anywhere from .65 to 10.6.

2.1.3 AUTO/MAN Switch

This two position toggle switch places the module in the "automatic" mode of operation or the "manual" mode of operation. In the AUTO position the indicating meter, the tape output amplifier, and the galvo output amplifier are automatically range switched. When the AUTO/MAN Switch is in the MAN position, the automatic range-changing circuitry is bypassed, and the module functions as a conventional, manually operated unit.

2.1.4 FULL SCALE RANGE (g) Switch (Standard)

This seven position rotary switch has the full scale settings engraved on the skirt of the knob. The manually selected full scale range setting is indicated by the left-hand pilot light along with the radial index line that is emphasized with an arrowhead. When the module is operating in the automatic mode, the other two pilot lights, along with their associated radial index lines, indicate the full scale range that has been selected by the AUTO-RANGER circuitry. Only one of the three pilot lights is energized at any one time. When the module is operating in the manual mode of operation, only the pilot light associated with the manually selected full scale range setting is energized.

2.1.5 DAMP-LO/HI Switch

This two position toggle switch determines the speed of response of the automatic range changing circuitry. When this switch is in the LO DAMP position, the AUTO-RANGER can be used to switch ranges anywhere in the frequency range of 20 Hz to 10 KHz, without causing the switching relays to operate on a per cycle basis. For operation to 5 Hz, it is recommended that the switch be placed in the HI DAMP position. The LO DAMP position provides the faster speed of response of the level detecting circuit, therefore, the LO DAMP position is recommended when tests are being run which involve resonant conditions and relatively high sweep speeds.

With the LOG. CONVERTER option, the DAMP LO/HI Switch controls the speed of response of the compressor circuit, as well as the minimum frequency of operation as outlined in Par. 1.9.

2.1.6 A & B ADJUSTMENTS

The A & B adjustments control the per cent of full scale at which the two switching conditions occur for the AUTO-RANGER option. The A adjustment controls the first level of switching and the B adjustment controls the second level of switching. These tripping level adjustments provide nominal ± 10% variation of the tripping level from the 100% of full scale value. These adjustments are not intended for frequent use, but only for special cases of testing and recording that may warrant their use.- such as compensating for the apparent change in tripping level when sweeping rapidly through a high Q resonance, if the recording methods make the increase in apparent switching level undesirable. The A & B 25 turn trimpot settings are factory set for a nominal 100% of full scale switching conditions.

With the LOG CONVERTER option, the A adjustment controls the gain of the converter section, and the B adjustment controls the spread of the logarithmic scale. They are usually adjusted sequentially to match a simulated 100 g signal to 80% of full scale and a simulated 0.1 g signal to 20% of full scale. The conversion equation for the log scale is

$$20 \log G_{peak} = (\text{PCT. OF FULL SCALE} - 40)\ \text{dB}$$

The scaling thus becomes 1 dB/PCT. FULL SCALE

2.1.7 GALV. GAIN

The ten-turn potentiometer varies the gain of the galvanometer driver channel from 0 - 100% of max. gain. The turns counting dial is equipped with a locking brake. The GALV. GAIN control is independent of the TAPE GAIN control.

2.1.8 TAPE GAIN

Identical to GALV. GAIN control except that the gain of the tape output channel is controlled.

2.1.9 MODE Switch

This four-position calibration switch is described in Par. 1.10.

2.1.10 FILTER Switch

The two-position FILTER Switch allows selection of either of two low-pass filter cutoff frequencies. The A position is the 5 kHz filter and the B position is the 10 kHz filter. The response is within 2% at the specified filter frequency and is down 3 dB at approximately 2 times the specified filter frequency.

2.2 Module Chassis Controls

2.2.1 10 mv/g Adj.

The access hole to this 25 turn Trimpot is located on the top of the chassis, toward the front. The normalization of the 10 mv/g output should be made with this potentiometer before the METER or F-CAL adjustments are made.

2.2.2 METER Adj.

The access hole to this 25 turn Trimpot is located on the top of the chassis, toward the rear. The potentiometer is used to normalize the full-scale meter indication, following the adjustment of the 10 mv/g potentiometer.

2.2.3 F-CAL.

The access hole to this 25 turn Trimpot is located on the top of the chassis, next to the hole for the 10 mv/g adjustment. The potentiometer is used to adjust for full-scale output with the MODE Switch in the F-CAL position and 100 mv peak applied to the OSC. input connector. The F-CAL adjustment must be made after the 10 mv/g adjustment, since the latter affects the former.

2.2.4 GALV. ZERO

The access hole to this 25 turn Trimpot is located on the top of the chassis near the METER ADJ. access hole. The GALV. ZERO pot. is used to adjust the d-c voltage at the GALV. output to zero. This voltage should not drift more than $\pm$ 50 mv.

2.2.5 Tape Code and Galv. Code Resistors and Capacitors

These components are mounted on the printed circuit board for the AUTO-RANGER. The value of the tape code resistors depends on the load resistance that the output is working into and on the desired code voltages. The value of the galv. code resistors depends only on the desired code voltages.

Refer to Section E for full discussion of code component selection.

2.3 Instrument Rear Panel Connectors

2.3.1 Separate BNC connectors are provided for the accelerometer input signal and the tape, galvo and servo output signals. The oscillator connectors are a pair of miniature phone jacks. The upper jack is for the incoming oscillator signal. The lower jack

2.3 Instrument Rear Panel Connectors

2.3.1 Separate BNC connectors are provided for the accelerometer input signal and the tape, galvo and servo output signals. The oscillator connectors are a pair of miniature phone jacks. The upper jack is for the incoming oscillator signal. The lower jack is for patching the calibration signal on to the next channel. If an internal calibration oscillator is located within any module, the internal signal is automatically disconnected when the external signal is plugged into the upper jack. The 3 pin CINCH type power connector mates with the Model 11R rack adapter power strip or the individual line cord. The rear mounted connector arrangement is shown in Figure 3 below:

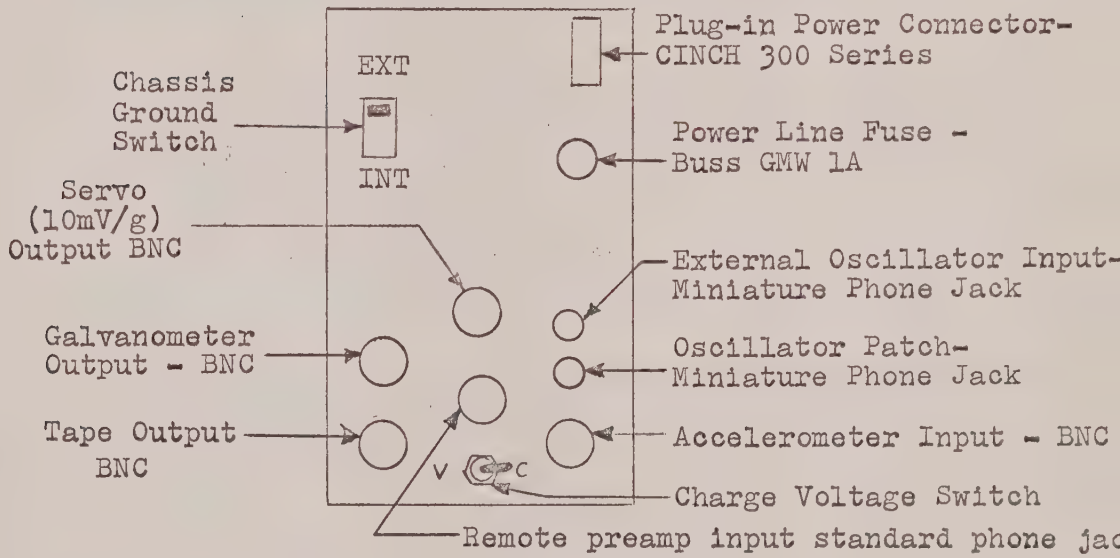


Figure 3 Rear Panel Configuration

2.3.2 Accelerometer Input Connector

The standard Model 11 uses a BNC connector for use with standard coaxial cable (preferably low noise). It can be readily converted for use with subminiature, low-noise Microdot cable with a Microdot 33-101 adapter.

Section B
OPERATING INSTRUCTIONS

1. Setup and Operating Procedure Using a Shaker

1.1 Connect the accelerometers to the channels to be used. Keep accelerometer cables away from power cord.

Only piezoelectric type transducers should be connected to the input since the charge amplifier will not function properly with a resistive source connected to its input. For minimum ground loop pickup the accelerometers must be isolated from ground at the mounting location by using isolating studs or an equivalent technique. Also, use of the TEST feature of this instrument requires that the return side of the accelerometer and cable be isolated from ground so that an external oscillator signal can be inserted at this point. If it is desired to convert the BNC input connectors for use with subminiature, low noise Microdot type cable, use Microdot 33-101 adapters.

1.2 Connect the tape, galvo, and servo (10 mv/g) outputs to the readout or control equipment as required. Make sure that the chassis is connected to signal ground as described in Section A, Par. 1.12.

1.3 Set the Sensitivity Range Switch in the 1-10 or 10-100 position as determined by the charge sensitivity of the accelerometer used with each particular channel. The units are pk-p©mb/pk-g.

1.4 Rotate the multiturn Sensitivity Dial until the numerical readout on the dial corresponds to the first three places of the accelerometer charge sensitivity. Lock the dial in position.

1.5 Set the MODE Switch in the NORM position.

1.6 Set the FULL SCALE RANGE (g) Switch to the lowest range for the vibration expected. This manually set full scale range is indicated by the index line that is terminated with an arrow. The pilot light associated with this index line will remain lit when the AUTO/MAN. Switch is in the MAN. position.

1.7 For Option A, set the AUTO/MAN Switch in the AUTO position when it is desired to maintain the signals being monitored within the full scale capabilities of the recording and readout equipment.

For the standard meter scale, the manually selected ranges are exactly 1, 3, 10, 30 etc. full scale. Since these ranges do not represent exactly equal spacings,

the automatic range selector is designed to indicate accurately only when the lowest range is 1, 10, or 100.

1.8 For Option A, set the DAMP Switch in the LO position when automatic range switching is to take place above 20 Hz. Set the DAMP Switch in the HI position when automatic range switching is to take place between 5 Hz and 20 Hz or when the AUTO/MAN Switch is in the MAN position.

1.9 For Option A, see Appendix for code resistor computation.

1.10 For Option L, set LOG/LIN Switch to LOG when logarithmic compression of meter, tape, and galvo outputs are desired. A 60 dB range from .1 to 100 g is available. If an accelerometer with 1-10 pC/g sensitivity is being used, a 60 dB range from 1 to 1000 g is available by switching the SENS. RANGE Switch to 10-100 pC/g.

1.11 For Option L, set DAMP switch to HI position when operation below 20 Hz is desired. Otherwise use the LO position, which also provides faster response.

1.12 Attach line cord to power connector on rear of chassis. Check fuse to make sure that it is not missing. Apply 115V 60 Hz power. Make sure power cord is not placed alongside accelerometer cable or twisted with it. Allow several minutes for circuit voltages to assume normal values.

1.13 Adjustment of the TAPE GAIN and/or GALV GAIN controls to provide the proper recording level can be accomplished for all the channels at one time by operating the shaker at some low frequency where the specimen acts as a rigid body and all accelerometers see the same motion. The "g" level can be determined by reading the meters or by monitoring the 10 mv/g output. When the shaker motion has been set to the desired "g" level, rotate the TAPE and/or GALV controls until the proper recording levels have been obtained. Lock the dials in position. If it is required to operate at full scale value without the automatic changing of ranges taking place, set the AUTO/MAN Switch in the MAN position until the outputs have been normalized, and then return the switch to the AUTO position before continuing with the normal operation of the instrument.

1.14 Set FILTER Switch to desired frequency. The lower filter frequency causes somewhat less wideband noise to be transmitted to the outputs.

2. Setup Procedure Using a Calibrating Oscillator

If it is impractical to vibrate the specimen during setup or if the accelerometers are not all vibrating at the same level due to resonances, an alternate method of setting the gain controls may be used. This method uses an oscillator to simulate a given vibration level. A precision capacitor in each channel converts the oscillator output in millivolts to

picocoulombs, thereby effectively making the oscillator a charge generator.

2.1 Connect the external oscillator to the OSC input connector at rear of Model 11 chassis.

2.2 Set the MODE Switch to F-CAL. It is not necessary to adjust the Sensitivity Dial or the F. S. RANGE (g).

2.3 Set the AUTO/MAN Switch to MAN or the LOG/LIN Switch to LIN.

2.4 Apply power as in par. 1.12, and allow several minutes for instrument to assume normal operating conditions. Make sure chassis is connected to signal ground.

2.5 Apply 100 mv peak or 70.7 mv rms from external oscillator.

2.6 Adjust TAPE GAIN and/or GALV. GAIN controls to provide the maximum desired recording level on the recording device. Lock the dials in position.

2.7 To return the instrument to operational conditions for use with accelerometer inputs, reduce the oscillator signal to minimum, set the MODE Switch in the NORM position, and readjust the control settings according to Par. 1.

2.8 If there is any question regarding the calibration accuracy of the Model 11, it can easily be checked by setting the MODE Switch to V-CAL, and the Sensitivity Dial, Sensitivity Range, and F.S. RANGE (g) to the appropriate values. The oscillator output voltage can then be set in millivolts (pk) equal to the product of the accelerometer sensitivity in pC/g and the "g" level to be simulated.

3. Test of Input Cable and Accelerometer Integrity

A check of the capacitance of the input cable, connector, and accelerometer may be obtained by inserting the oscillator signal in the return side of the input cable. A change of the source capacitance due to opens or shorts is reflected by a change in the output of the Model 11 from the expected value.

3.1 Connect the input accelerometer according to Par. 1.1

3.2 Connect the external oscillator to OSC. connector.

3.3 Set the Sens. Dial to 10.0 and the Sens. Range to (10-100)

3.4 Set the F.S. RANGE to 10 g, and AUTO/MAN Switch to MAN.

3.5 Set the MODE SW to V-CAL.

3.6 Apply power. Wait several minutes.

3.7 Apply 1 V peak or .707 v rms from oscillator. This should result in a full scale output on meter, tape, and galvo circuits.

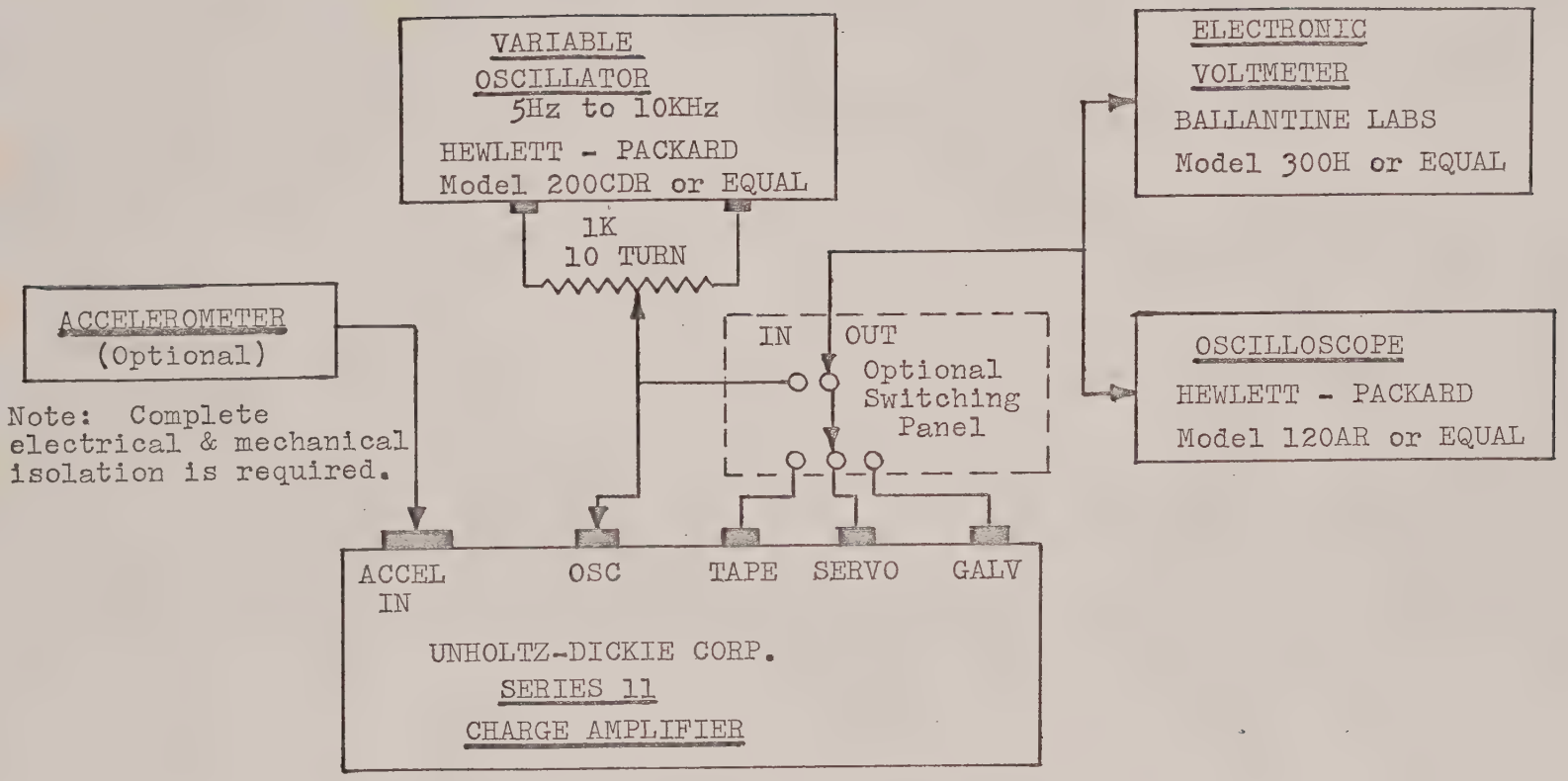
3.8 Keep oscillator input constant, and turn MODE Switch to TEST position.

3.9 Reset F.S. RANGE Switch if necessary, and record output from meter or appropriate circuit.

3.10 The input capacitance is determined by

$$C_c + C_a = \frac{\text{simulated "g" out in Par. 3.9}}{10} \times 1000 \text{ pf}$$

3.11 Reduce oscillator voltage to a minimum.



SERIES 11 CHECKOUT INSTRUMENTATION BLOCK DIAGRAM

FIGURE 4.

Section C

CALIBRATION AND CHECKOUT PROCEDURE

1. Operating Instructions

Before attempting a check of the performance of the Series 11 instrument, read Sections A and B thoroughly, and study Figures 1, 2, and 3 carefully.

2. Instruments Required

2.1 Audio Oscillator (1 Hz to 100 kHz preferred).

2.2 A.C. Electronic Voltmeter

2.3 Oscilloscope (direct coupling preferred)

3. Instrument Connections

3.1 OSC. - Connect audio oscillator to OSC connector. A step attenuator between the oscillator and the Model 11 is often useful.

3.2 OUTPUT SIGNALS - The oscilloscope (CRO) and AC Electronic Voltmeter (ACVM) may be connected to any of the three output jacks: TAPE, GALV, or SERVO. Follow the grounding instructions for proper use of the "INTERNAL - EXTERNAL" Ground Switch, that is located at the rear of the unit (shown in Figure 3).

3.3 ACCEL. - For a bench check of the Series 11 Instrument, it is not necessary to have a cable and accelerometer attached to the ACCEL. input. However, if none is attached, the ACCEL. input should be covered but not shorted to ground to prevent 60 Hz pickup.

Only piezoelectric accelerometers should be attached to ACCEL. or shielded capacitors to simulate cable loading. If an accelerometer is attached, it should be set on cushioning material to minimize spurious signals generated by the accelerometer.

3.4 Whenever measurements are being made use both the CRO and ACVM to insure purity of waveform and absence of power line pickup.

4. Initial Instrument Settings

4.1	SENS. Range Switch	- (1-10) pC/g
4.2	SENS. Dial	- 10.0
4.3	Full Scale Range	- 10 g
4.4	MODE Switch	- V-CAL

4.5 FILTER - B Position

4.6 Oscillator

4.6.1 Frequency - 1 kHz

4.6.2 Amplitude - 100 mV peak (70.7 mV rms)

4.7 Apply power to the Series 11 instrument and allow several minutes for normal operating voltages to be fully established.

5. Calibration of GALV Output, TAPE Output, and Meter

5.1 Attach CRO and ACVM to GALV output connector. If the GALV feature is not supplied, use the TAPE output instead.

5.2 With settings in Para. 4, set 10 mV/g Trimpot (accessible from top of chassis) to provide 5.0 volts peak (3.54 volts rms) plus about 2% when the GALV GAIN pot is set full CW.

5.3 Readjust GALV GAIN to provide exactly 5.00 volts peak.

5.4 Adjust TAPE GAIN to provide 1.00 volts peak (.707 V rms).

5.5 Set METER trimpot (accessible from top of chassis) to provide a 100% full scale or 10 g reading.

6. Calibration of F-CAL Mode

6.1 With settings in Para. 4 and TAPE output set at 1.0 volt peak for full scale input, change the Mode Switch from the V-CAL position to the F-CAL position.

6.2 Adjust the F-CAL trimpot (accessible from top of chassis) until the TAPE output is 1.0 volt peak. This reading, as well as the meter indication, should be independent of the SENS. Dial setting, SENS. Range, and F.S. RANGE Switch setting.

7. Calibration of Sensitivity Dial Offset

7.1 With the settings in para. 4, the TAPE output should be set to provide exactly 1.00 volts peak.

NOTE: The SENS. Dial offset has been factory set and should not normally require routine adjustment.

7.2 Decrease oscillator voltage to 10 mV peak (7.07 mV rms). Set SENS. Dial to 1.00. The output voltage should be 1.00 volts peak ± 1%.

7.3 If output voltage is too high in Para. 7.2, turn SENS. Dial CCW until stop is reached. Note reading on dial. Loosen set screw on knob and decrease dial setting by one minor division for each 2% of error in Para. 7.2. Lock setting,

replace dial and tighten set screw, taking care not to move the pot shaft off the CCW stop.

7.4 If output voltage is too low in Para. 7.2, follow instructions in 7.3 but increase dial setting.

7.5 One adjustment of the dial offset is usually sufficient if the initial measurement in 7.2 indicates the offset is out of calibration by only a few per cent.

8. Clipping and Maximum Output Capability

8.1 Set SENS. Dial at 1.0, SENS. Range at 1-10, and FULL SCALE RANGE (g) at 1000 g.

8.2 Apply 1.00 v peak (.707 V rms).

8.3 Monitor waveform at TAPE output. No clipping or distortion at the peaks should be evident.

8.4 Increase TAPE GAIN to 10.0 (full CW). At least 3.54 v rms (5.00 v peak) should be measured at TAPE output. Clipping should not be evident.

9. FULL SCALE RANGE (g) Switch

9.1 Set SENS. Dial at 10.0, SENS. Range at 1-10, and F.S. RANGE (g) at 1000 g. Apply 7.07 v rms at 1 kHz to OSC input. Adjust TAPE GAIN until voltage monitored at tape output is .707 v rms.

9.2 The voltage monitored at TAPE output should be .707 $\pm$ .007 v rms for the following combinations of input voltages and F.S. RANGE (g) settings:

Input Voltage (rms mv.)	F.S.RANGE (g)
2121	300 g
707	100 g
212	30 g
70.7	10 g
21.2	3 g
7.07	1 g

10. Frequency Response

10.1 Set SENS. Dial at 10.0, SENS. Range at (1-10) and F.S. RANGE (g) at 100 g. Apply .707 v rms at 1 kHz. Adjust the TAPE GAIN and GALV. GAIN until the voltages at the TAPE and GALV. outputs are both .707 v rms.

10.2 At other frequencies with the settings as in 10.1, the tolerances on the unity gain situation are in the table below:

FREQ.	2 Hz	5 Hz	10 Hz	5 kHz	10 kHz	20 kHz
FILTER-POSITION A	± 5%	± 2%	± 1%	+ 2%	Approx-3dB	-
FILTER-POSITION B	± 5%	± 2%	± 1%	+ 1%	± 2%	Approx-3dB

Below 10 Hz, voltage measurements should be made on a direct-coupled oscilloscope.

11. GALV. Maximum Output (Option G)

11.1 Using a direct coupled oscilloscope or a d.c. voltmeter monitoring the GALV. output, adjust the GALV. trimpot (accessible from top of chassis) until the d.c component of output voltage is zero.

11.2 With settings as in 8.1 and 8.2, turn GALV. GAIN full CW to 10.0. Measured voltage at GALV. output should be at least 5.00 v peak (3.54 v rms). No clipping should be evident.

11.3 Turn GALV. GAIN CCW until output voltage is 3.0 v rms (4.25 v peak). Connect a 50 ohm resistor across the output. Clipping should not occur. This test condition produces 85 Ma peak load current. Output voltage will drop slightly due to output impedance of GALV. output and cable impedance.

12. Noise Level

12.1 Connect the ACVM and the CRO to the TAPE output and adjust the TAPE GAIN potentiometer so that 0.707 v rms corresponds to full scale indication. With a nominal 10 pC/g accelerometer and 100 ft. of low-noise coaxial cable connected to the Accel. input, set the SENS. Dial to 10.0, the SENS. Range to (1-10) and the F.S. RANGE (g) to 1.0 g.

12.2 Put the MODE Switch in the NORM position. Make sure that the grounding instructions for proper use of the INTERNAL-EXTERNAL Ground Switch are carried out. The output noise should be less than 1.7 mV rms.

12.3 Change the SENS. Dial to 1.0 and SENS. Range to (10-100). Allow the instrument to reach equilibrium conditions. The output noise should be less than 6.6 mV rms.

12.4 For the readings in 12.2 and 12.3 the accelerometer should be kept absolutely motionless. Packing it loosely in spongy material approximates this condition. A capacitor can be substituted for the accelerometer and cable in the above tests, but it must be in a shielded box. The power frequency components for the above tests are typically 20-30% of the observed noise. It may be necessary to shield the coaxial cable in a duct or can as long as coaxial cables tend to pick up 60 Hz components in the circular shield.

Section D

MAINTENANCE

1. Spare Parts

1.1 Fuse 1 Amp. Bussman GMW 1

1.2 Transistors

	(No. Required)	
2N3458	(2)	Amelco
2N2484	(28)	TI
2N699	(8)	TI or RCA
2N2668	(1)	TI
2N2905	(1)	TI

1.3 Diodes

IN936	(1)	Motorola or Hoffman
IN3122	(8)	Amperex
35G5	(9)	Edal Industries
ZD30B	(3)	Diodes, Inc.
ZD20B	(1)	Diodes, Inc.
ID30B	(1)	Diodes, Inc.
IN3000B	(1)	Motorola or TI
ZD4.7A	(1)	Diodes, Inc.

1.4 Relays

3SBF5005MI	(2)	General Electric

2. Voltage Charts

Circuit Schematic Dwg. No. 910 _____

Description	Board Location	Typical DC Voltage
Q2 Emitter	A	12 to 22
Q7 Collector	A	25 to 35
Q9 Emitter	B	8 to 20
Q12 Collector	B	12 to 18
Q14 Collector	K	10 to 22
Q17 Emitter	K	10 to 13
Q20 Emitter	K	12 to 18
Q23 Emitter	K	12 to 18
Q21 Collector	F	10 to 20
Q22 Collector	F	12 to 18
Across 10 Ω Emitter ckt. Q24	E	.9 to 1.1
Q26 Emitter	D	3 to 5
Q27, Q33 Collector	D	10 to 20
Q28, Q34 Collector	D	10 to 20
Q29, Q35 Emitter	D	6.5 to 9
Q29, Q35 Collector	D	21 to 23.5
Q31, Q37 Emitter	D	1.3 to 1.4

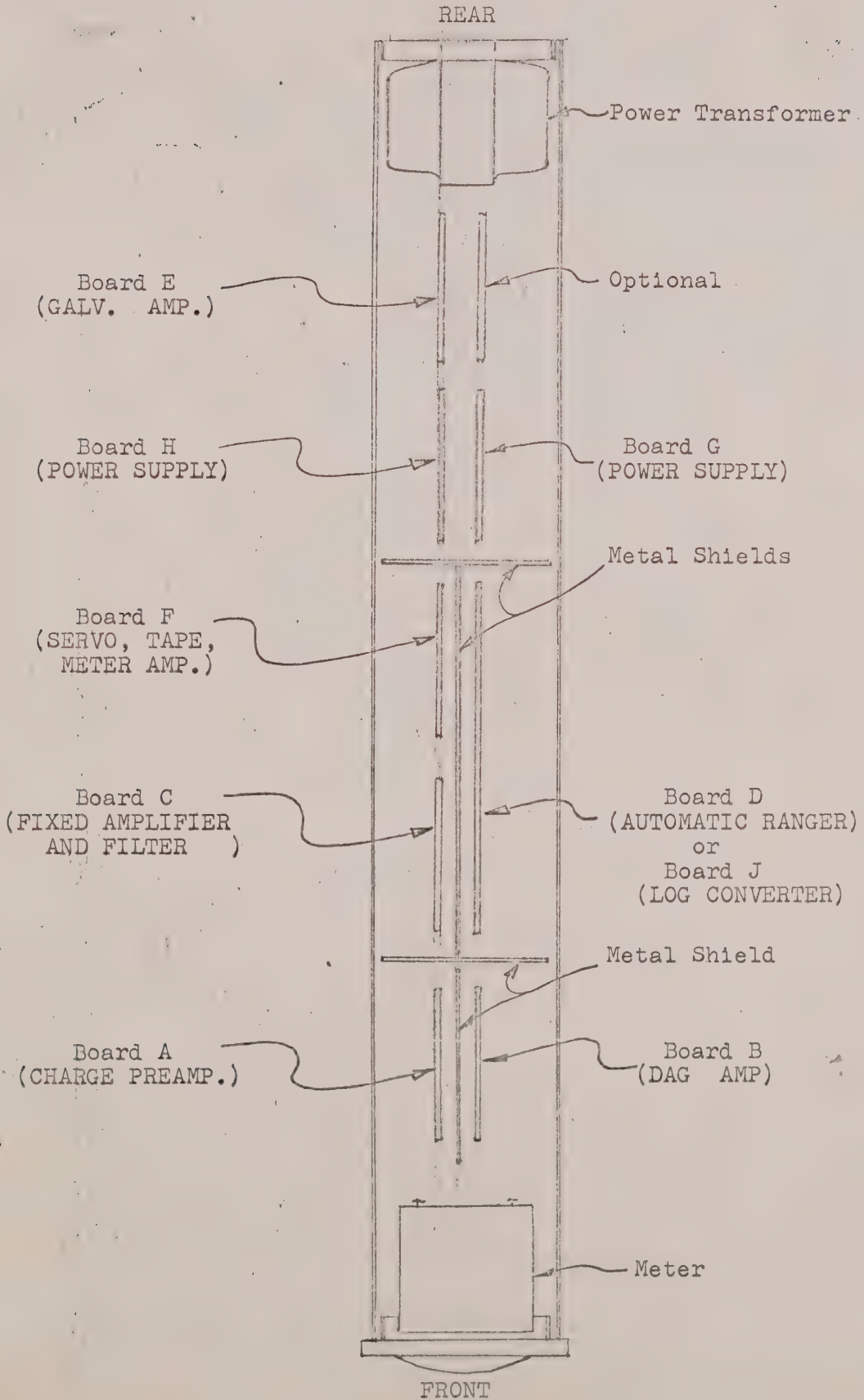
Typical Voltages for the power supply are located on the power supply schematic, drawing No. 910_____.

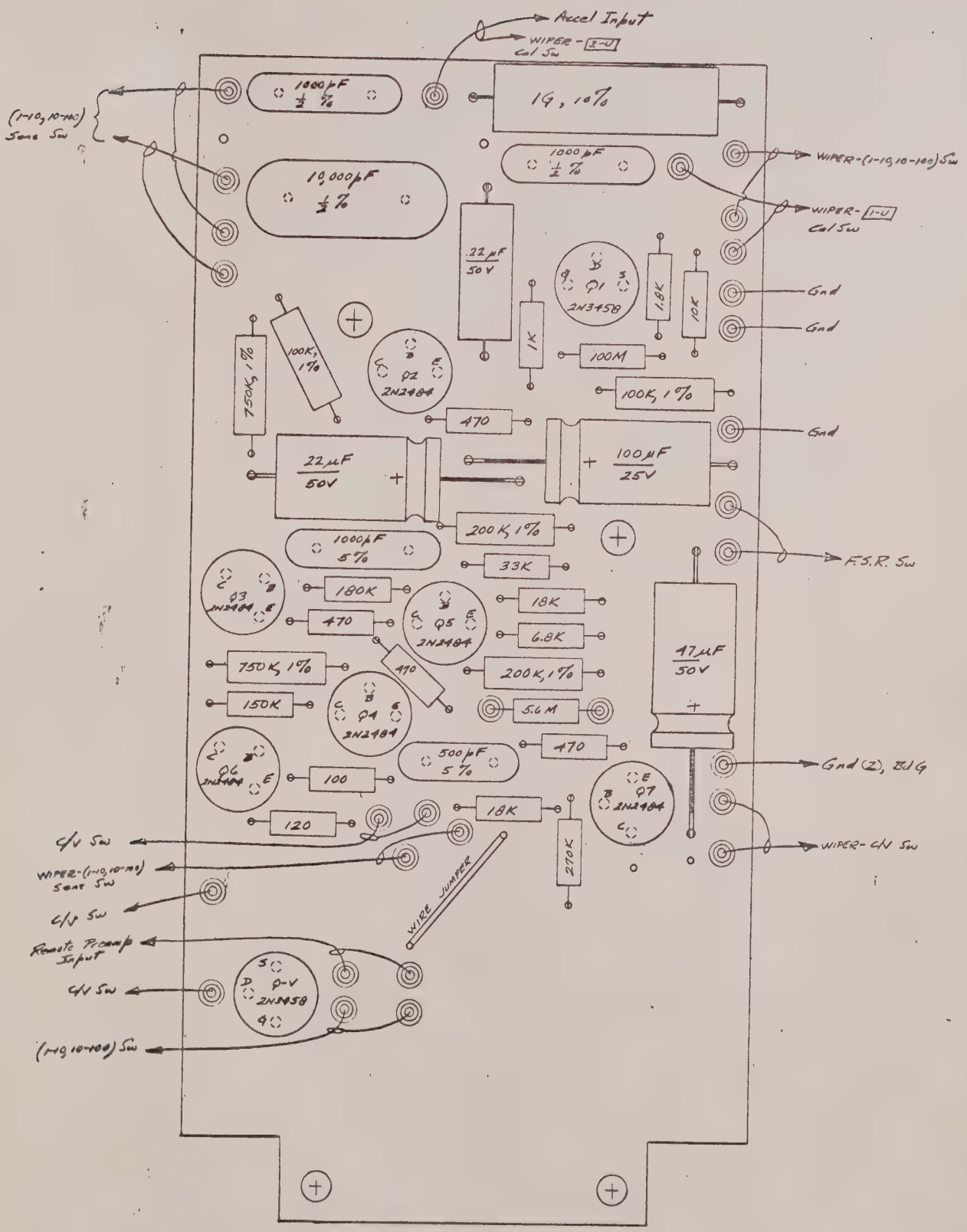
3.0 Physical Location of Components

Figure 5 is a simplified view of the Model 11 Series Charge Amplifier with the top plate removed, showing the location of the major components and circuit boards. On the pages following Fig. 5 are 2X layouts of the applicable printed circuit boards, showing the location of the components.

Model 11 Series

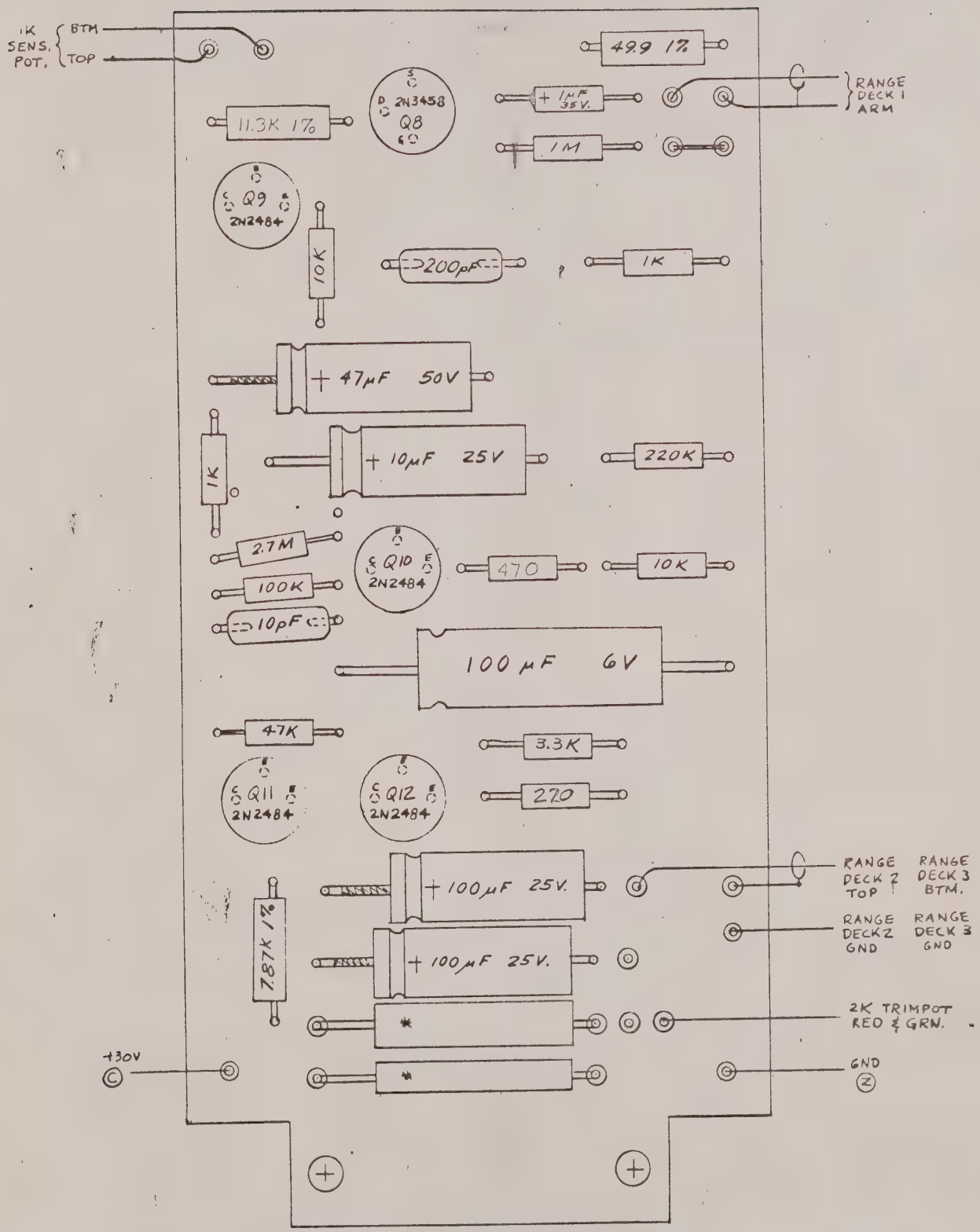
TOP VIEW TOP PLATE REMOVED





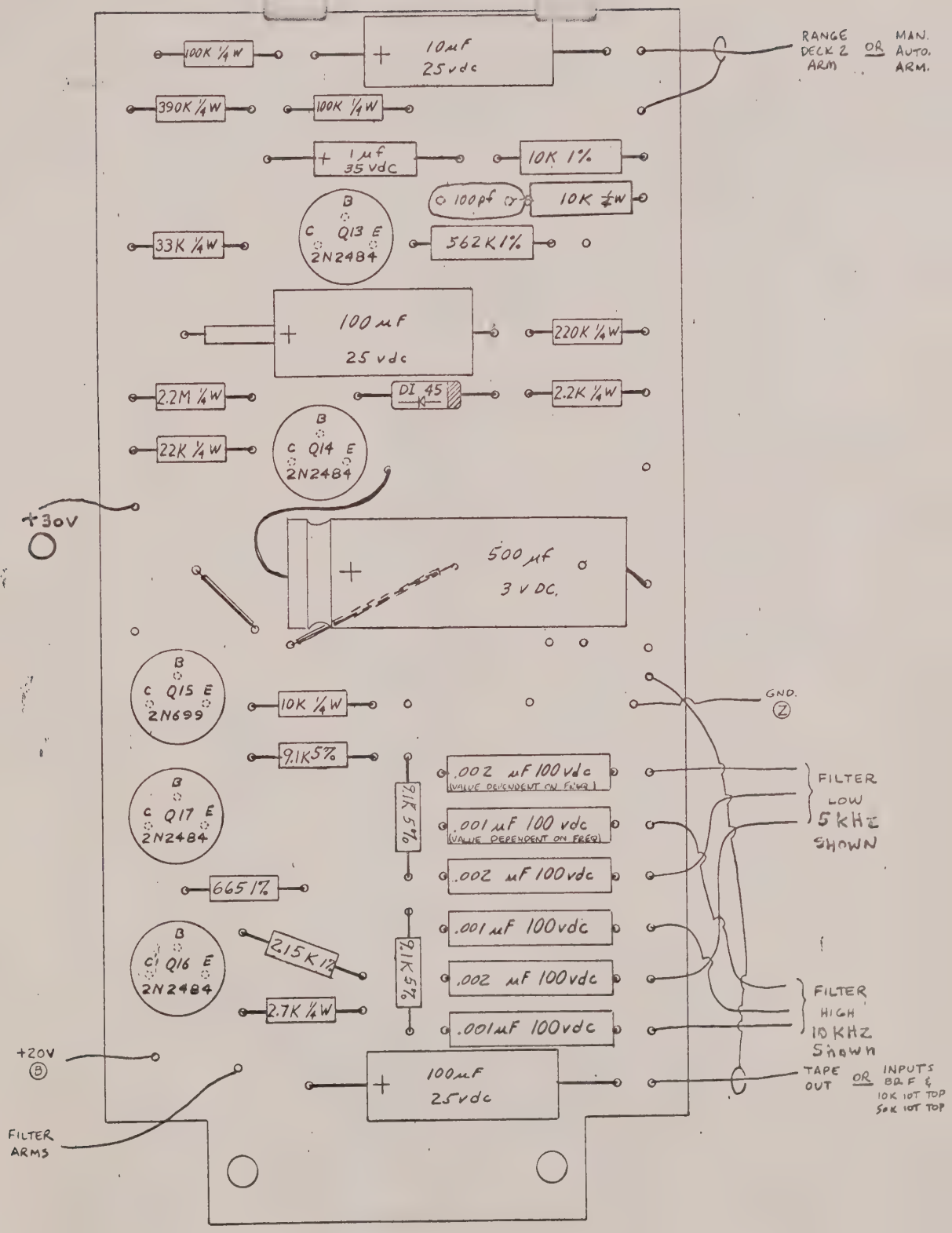
CHARGE PREAMPLIFIER

Circuit Board A



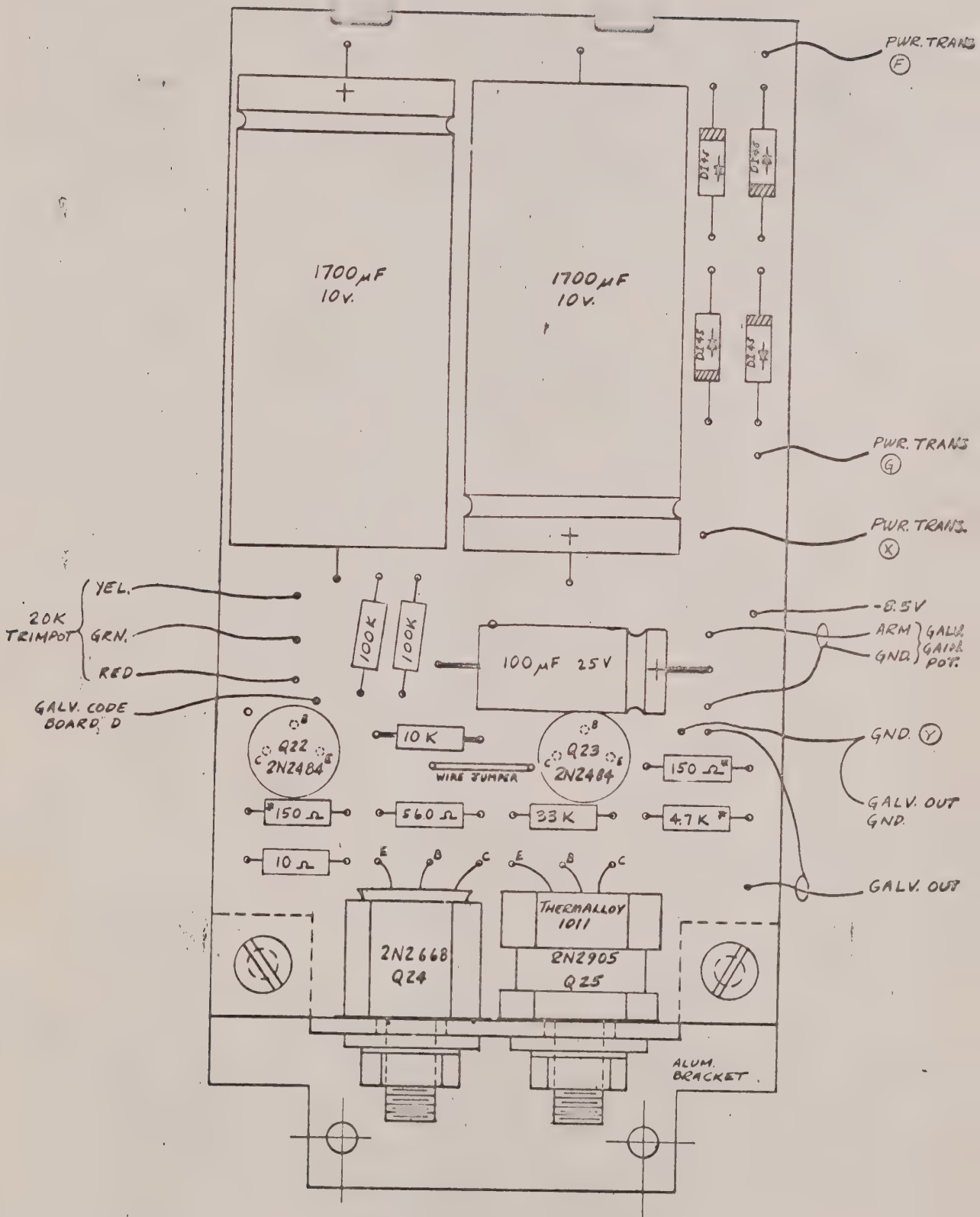
DIAL-A-GAIN AMPLIFIER

Circuit Board B



FIXED-GAIN POSTAMPLIFIER AND FILTER

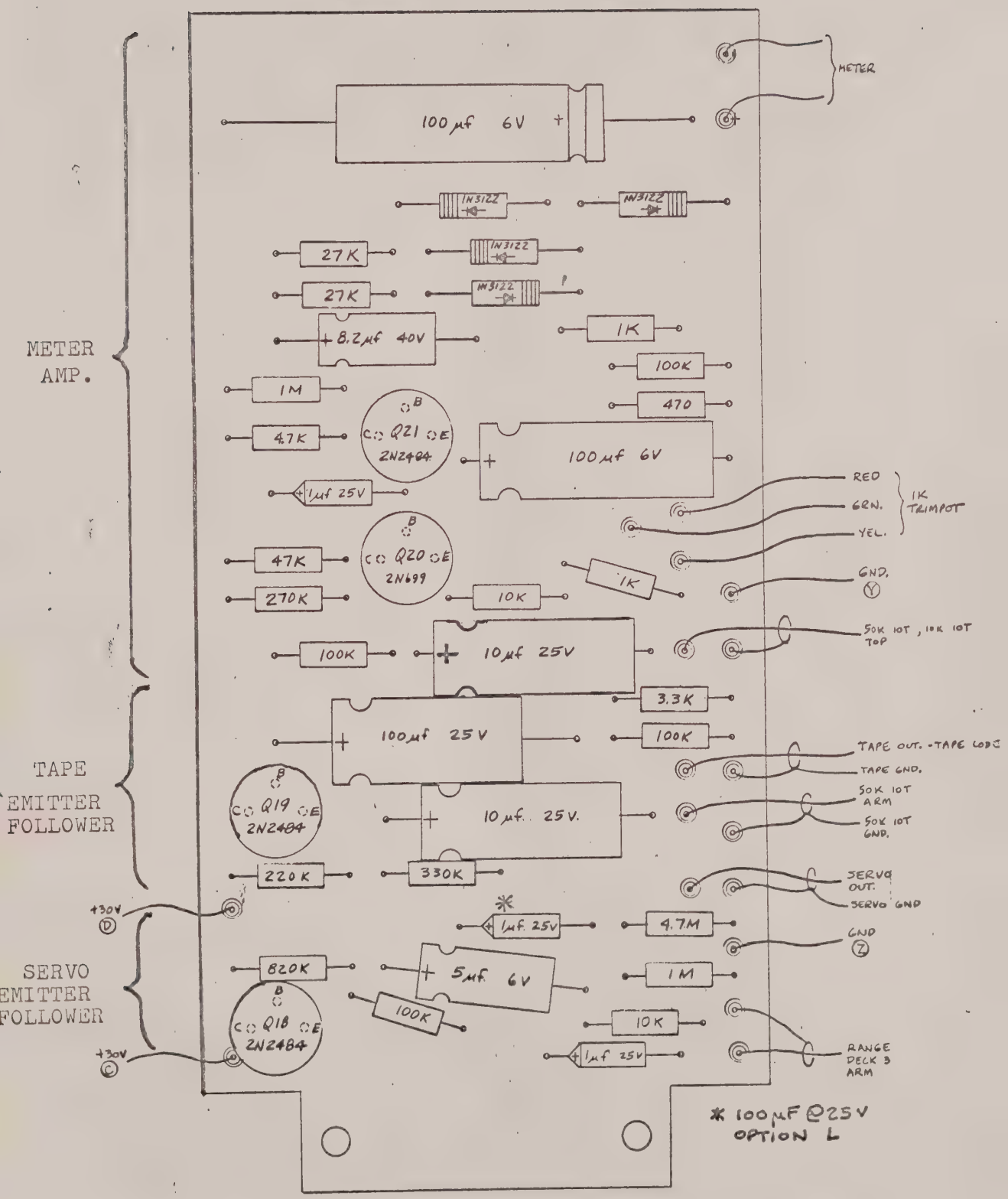
Circuit Board C



GALVANOMETER OUTPUT (CURRENT) AMPLIFIER

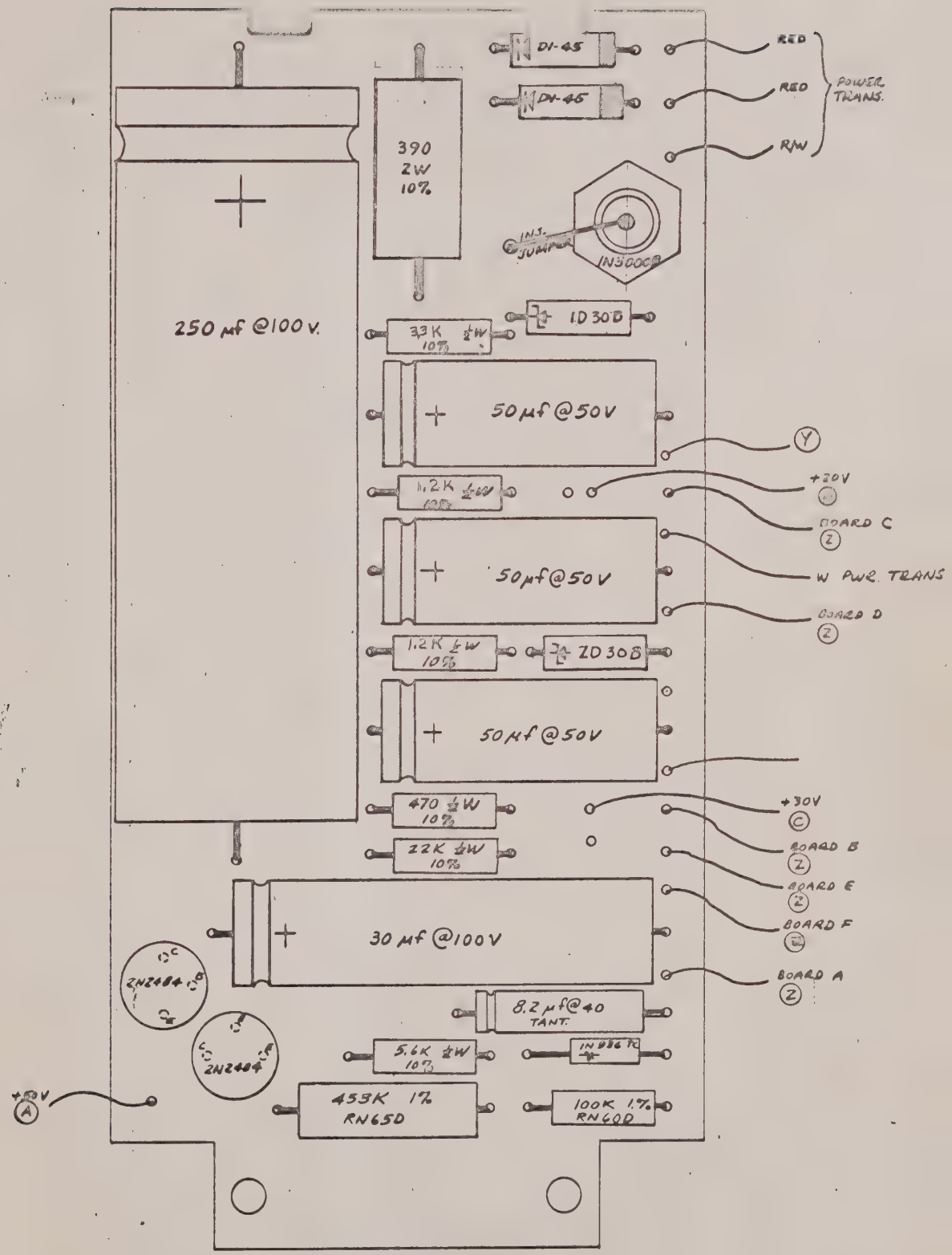
* MAY BE SHUNTED

Circuit Board E



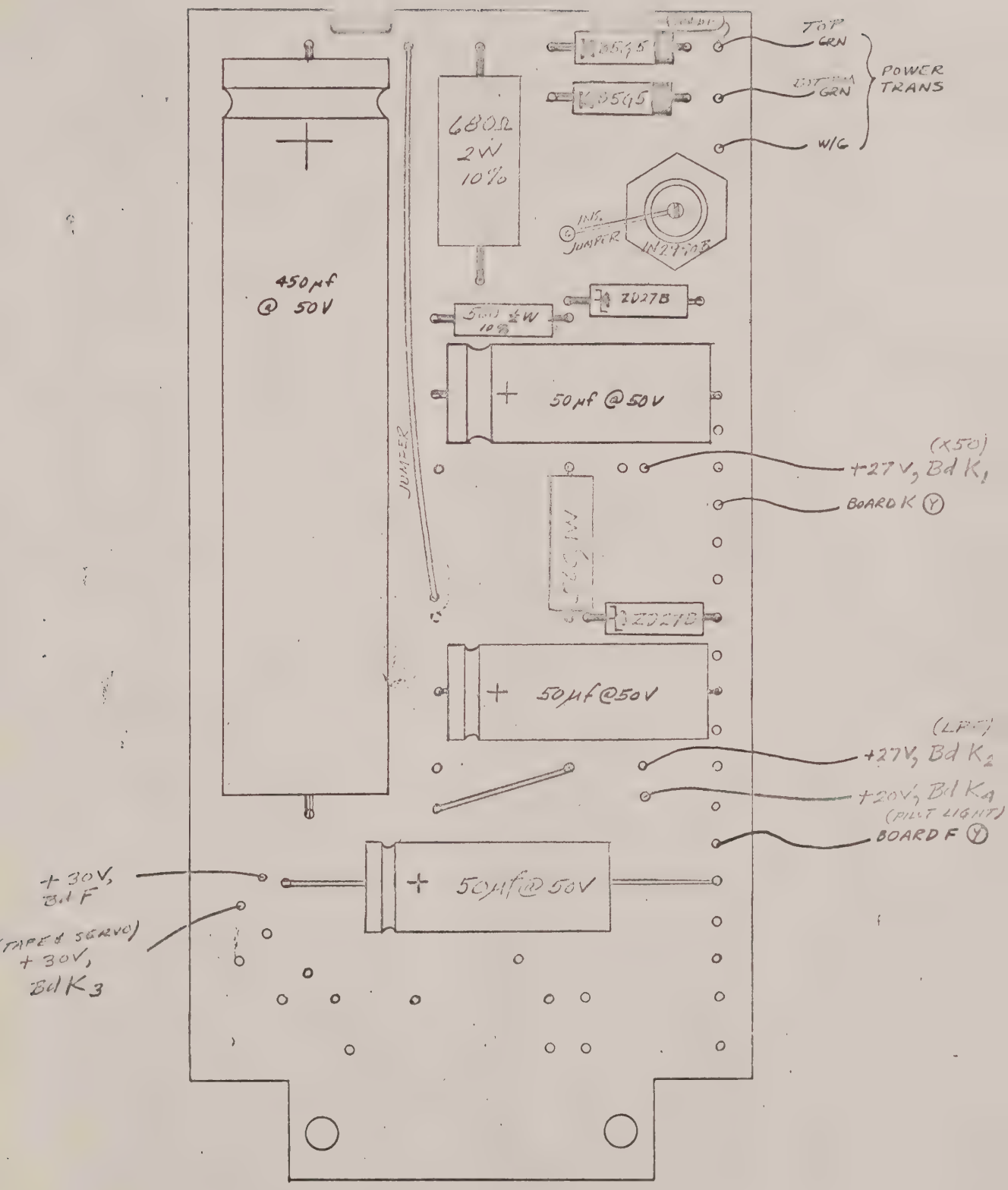
METER AMPLIFIER, TAPE AND SERVO EMITTER FOLLOWERS

Circuit Board F



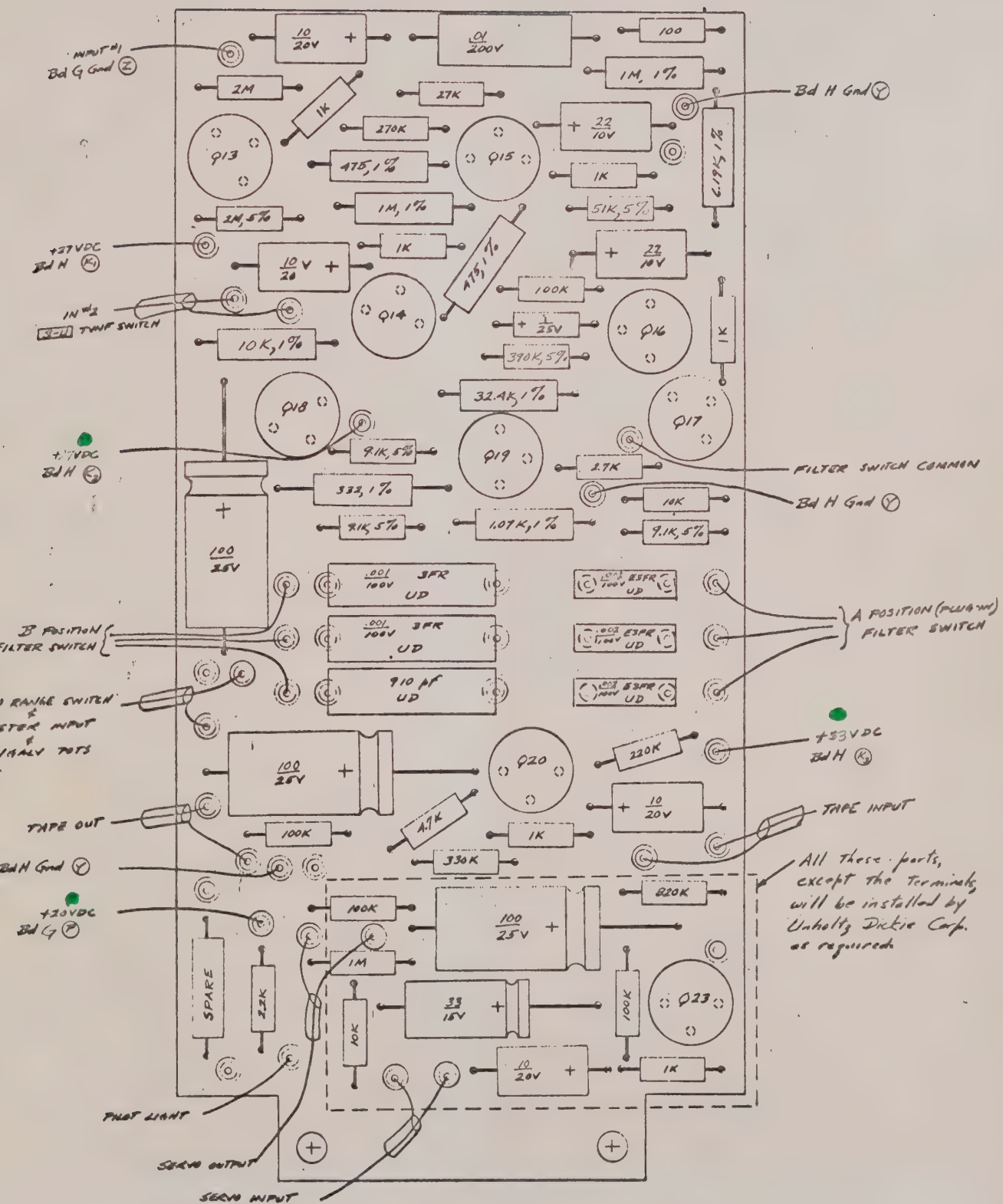
MAIN POWER SUPPLY

Circuit Board

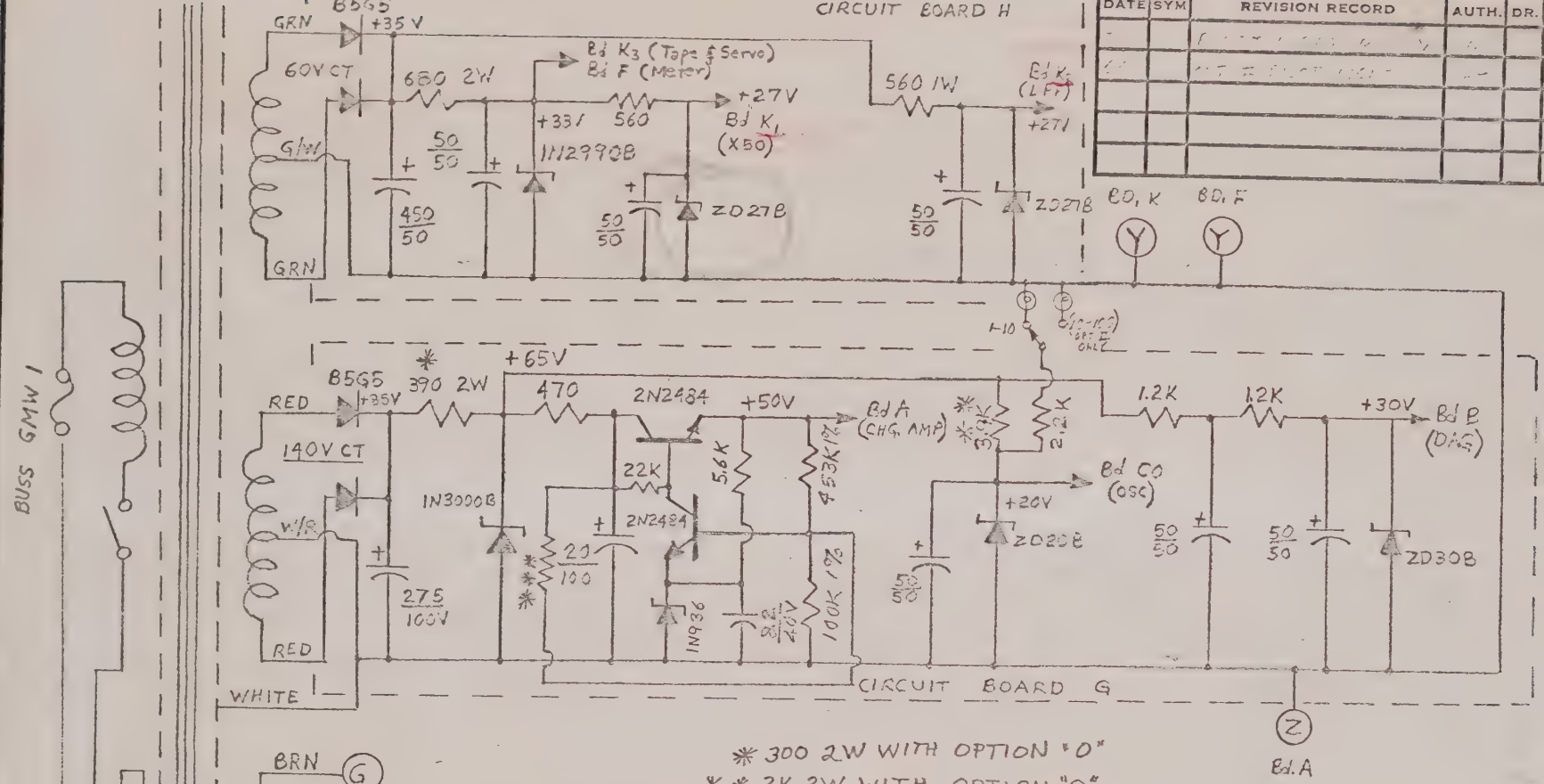


AUXILIARY POWER SUPPLY

Circuit Board H, D11 SERIES



X50 AMPLIFIER/LOW PASS FILTER,
TAPE DRIVER, SERVO DRIVER (OPTIONAL)
CIRCUIT BOARD K



DATE	SYM	REVISION RECORD	AUTH.	DR.	C.

* 300 2W WITH OPTION "O"

** 2K 2W WITH OPTION "O"

*** FACTORY SELECT

TOLERANCES (EXCEPT AS NOTED)	UNHOLTZ - DICKIE CORP.		
DECIMAL ±		SCALE	DRAWN BY JHT APPROVED BY
FRACTIONAL ±	TITLE POWER SUPPLY CIRCUIT SCHEMATIC MODEL DII SERIES CHARGE AMPLIFIER		
ANGULAR ±	DATE 4-29-63	DRAWING NUMBER 910 6289	

K&E ALBANENE ® 10 5465 ENGINEERS' STANDARD FORM

MADE IN U. S. A. 28359

From the manufacturer of complete vibration test systems

UNHOLTZ-DICKIE

Instrument Bulletin

Offering a complete line of
signal conditioning instruments
and accelerometers for vibration

RIGINATORS OF THE CALIBRATED SENSITIVITY DIAL
UTORANGING ▪ RANGE RESTORING ▪ AUTOMATIC CALIBRATION
LOTTING SYSTEMS ▪ HIGH POWER TRANSISTOR AMPLIFIERS

SHOCK AND VIBRATION MONITORING INSTRUMENTS

Unholtz-Dickie instruments can be categorized as two general types

COMPACT SIGNAL CONDITIONING MODULES FOR MULTI-CHANNEL DATA ACQUISITION SYSTEMS

These units are generally charge type amplifiers with switchable voltage modes of operation. Their modular construction permits the building block approach and the combination of various features. They have full scale range switching, a direct reading sensitivity dial, variable gain tape output, and optional galvo output, 10mV/g servo output, and meter. Built-in CAL and TEST functions are standard. Other features include AUTO-RANGING, LOG COMPRESSION, extended low frequency response, and compatibility with grounded accelerometers. Wide dynamic range and frequency response are particularly suitable for shock measurements.

DIAL-A-GAIN INSTRUMENTS FOR VIBRATION EXCITER SYSTEMS AND GENERAL LABORATORY USE

These units are generally voltage type amplifiers with normalized 1 V rms/g pk and 10 mV pk/g pk outputs. They are general purpose portable or rack mounted instruments. All have the DIAL-A-GAIN feature — a calibrated sensitivity dial for direct dialing of the transducer sensitivity. Some models read out velocity and displacement in addition to the standard acceleration output. Tape and galvo recording of both acceleration and displacement are available. High accuracy, precision, standardizer DIAL-A-GAIN instruments are used in accelerometer calibration systems and combine switchable charge and voltage inputs with the double integration feature.

GENERALIZED INPUT CHARACTERISTICS

TYPE INPUT	INPUT CABLES GENERALLY USED	TYPICAL NOISE LEVELS (referred to input)	GAIN RANGE	COMMENTS
High Input Impedance, Straight Voltage: DAG Series, 608 Series (Voltage mode)	50 ft or less of subminiature, low noise cable.	DAG Series: <100 μV rms 608 Series: <35 μV rms	DAG Series: 10 to 1000 608 Series: 0 to 10,000	Compatible with wide variety of transducers. Calibration depends on input cable length.
Charge Converter: Model 11 Series, 608 Series	Up to 300 ft of coaxial cable. Connection to accelerometer is subminiature, low noise cable with optional conversion to RG/U coaxial cable runs.	Model 11 Series: .003 pC rms + .002 pC rms/1000 pF 608 Series: .03 pC rms + .01 pC rms/1000 pF	Model 11 Series: 0 to 5,000 mV/pC 608 Series: 0 to 10,000 mV/pC	Calibration is independent of cable lengths normally used. Model 11 series achieves ultra low noise levels for short input cables. Low noise cable required when cable whip is expected.
Remote Impedance Converter: Model 11PA-2 with Model 11 Series (Voltage Mode)	Short length of subminiature, low noise cable connected to accelerometer, and up to 2000 ft of RG/U coaxial cable to rack mounted instrument.	<35 μV rms	unity	Low output impedance drives long cables and uses standard RG/U coaxial types. Compatible with wide variety of transducers. Calibration depends on input cable length.
High Input Impedance, Driven Shield Voltage: 610 Series	25 to 100 ft of special triaxial cable with short length of subminiature low noise cable connected to the accelerometer.	<100 μV rms	0 to 7,000	Reduces capacitance loading effects on accelerometer. Calibration depends on input cable length.

		MODEL	19″ Wide Rack Mount	Channels in 19″ Width	Portable	Voltage Input (High Impedance)	Charge Input	Voltage Input with Remote Model 11PA-2	1V rms/g peak Normalized Output	10 mV/g Normalized Output	96.4 mV/in/sec Velocity and 1V rms/in DA Disp. Outputs	Adjustable Full Scale Tape Output	Adjustable Full Scale Galvo Output	
DIAL-A-GAIN SERIES		601		1	✓	✓			✓	✓				pg. 6
		601R-A	✓	1		✓			✓	✓				pg. 6
		602		2	✓	✓			✓	optional				pg. 6
		602R	✓	2		✓			✓	✓				pg. 6
		603R	✓	4		✓			✓	✓				pg. 6
		606M		1	✓	✓			✓	optional				pg. 6
		606RM	✓	1		✓			✓	optional				pg. 6
		610RM	✓	1		✓			✓	optional	✓			pg. 6
		610RMG-3	✓	3		driven shield			✓	✓	✓	0-5 V pk	0-10 V pk	pg. 6
		V608R-12A	✓	1		✓			✓	✓	✓			pg. 6
		CV608R-12A	✓	1		✓	✓		✓	✓	✓			pg. 6
608 SERIES		8PMCVA	with 608R	1-6	with 608PS-1	✓	✓			✓		0-2.5Vpk	0-10 V pk	pg. 5
		8PMCV	with 608R	1-6	with 608PS-1	✓	✓			✓		0-2.5Vpk	0-10 V pk	pg. 5
		8PCV	with 608R	1-6	with 608PS-1	✓	✓			✓		0-2.5Vpk	0-10 V pk	pg. 5
		8PMXCV	with 608R	1-6	with 608PS-1	✓	✓			✓		0-2.5Vpk	0-10 V pk	pg. 5
		8PXCV	with 608R	1-6	with 608PS-1	✓	✓			✓		0-2.5Vpk	0-10 V pk	pg. 5
MODEL 11 SERIES	BASIC	D11V	with 11R	1-6	✓		✓	✓		optional		0-5 V pk		pg. 4
		D11MV	with 11R	1-6	✓		✓	✓		optional		0-5 V pk		pg. 4
		D11GV	with 11R	1-6	✓		✓	✓		optional		0-5 V pk	0-5 V pk	pg. 4
		D11MGV	with 11R	1-6	✓		✓	✓		optional		0-5 V pk	0-5 V pk	pg. 4
	AUTORANGER	11MAV	with 11R	1-6	✓		✓	✓		optional		0-5 V pk		pg. 4
		11GAV	with 11R	1-6	✓		✓	✓		optional		0-5 V pk	0-5 V pk	pg. 4
		11MGAV	with 11R	1-6	✓		✓	✓		optional		0-5 V pk	0-5 V pk	pg. 4
	LOG AMP	11MSLV	with 11R	1-6	✓		✓	✓		optional		0-5 V pk		pg. 4
		11GSLV	with 11R	1-6	✓		✓	✓		optional		0-5 V pk	0-5 V pk	pg. 4
		11MGSLV	with 11R	1-6	✓		✓	✓		optional		0-5 V pk	0-5 V pk	pg. 4
	w/11PA-2	V11MS	with 11R	1-6	✓			✓		✓		0-5 V pk		pg. 5
		V11GS	with 11R	1-6	✓			✓		✓		0-5 V pk	0-5 V pk	pg. 5
		V11MGS	with 11R	1-6	✓			✓		✓		0-5 V pk	0-5 V pk	pg. 5

CHARGE/VOLTAGE AMPLIFIERS FOR

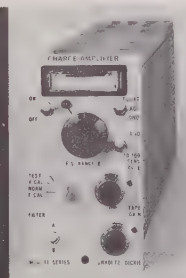
conditions signals from piezoelectric tran

MODEL 11 SERIES CHARGE AND VOLTAGE WITH INDIVIDUAL POWER SUPPLIES

This new series of signal conditioning amplifiers features individual double shielded power supplies, vinyl-clad, totally enclosed case, solid state printed circuitry, ultra low noise levels, portability of separate units, wider frequency range, and switchable charge or voltage operation. Panel height only 5¼ inches with meters. Full scale ranges of .1 g to 10K g with accelerometer sensitivities from 1 pC/g to 100 pC/g.

D11 SERIES

Model D11V
Tape output only
$525.00



Model D11MV
Tape and meter
$575.00

Model D11GV
Tape and galvo
$590.00

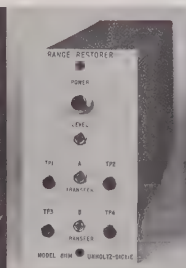
Model D11MGV
Tape, galvo, meter
$640.00

Basic D11 series permits operation with grounded accelerometers while eliminating usual ground loop problems. Differential circuitry provides rejection of common mode signals by a factor of 1000 or more.

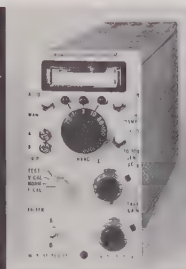
OPTIONAL FEATURES

S	10mV/g Servo Output	$50.00
O	1 kHz Internal Calibration Oscillator — fixed amplitude, sine wave	$50.00
F	Floating DC output for amplifiers supplied with meters	$25.00
—8	Large Meter (2½ inch scale) with 8¾ panel height	$20.00
LFI	Extended low frequency response (±5% down to 0.2 Hz)	$50.00

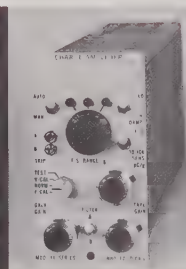
AUTORANGER SERIES



Model 811M
Range restorer
$1200.00



Model 11 MAV
Tape and meter
$745.00



Model 11 GAV
Tape and galvo
$760.00

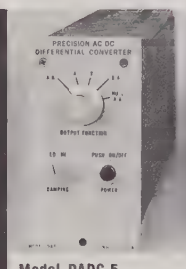
Model 11 MGAV
Tape, galvo, meter
$810.00

AUTORANGER series selects best of 3 adjacent full scale ranges. Pilot light and dc code signals indicate range selected. Range sequences of 1, 3, 10 . . ., or 1, $\sqrt{10}$, 10 . . . or 1, 10, 100 . . . are offered. Companion RANGE-RESTORER converts tape recorded data to original dynamic range.

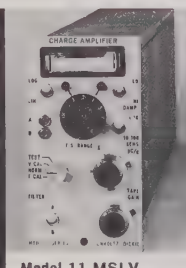
OPTIONAL FEATURES

S	10mV/g Servo Output	$50.00
O	1 kHz Internal Calibration Oscillator — fixed amplitude, sine wave	$50.00
F	Floating DC output for amplifiers supplied with meters	$25.00
—8	Large Meter (2½ inch scale) with 8¾ panel height	$20.00

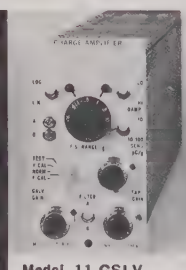
LOG AMP SERIES



Model DADC-5
Differential AC-DC converter
$1400.00



Model 11 MSLV
Tape and meter
$800.00



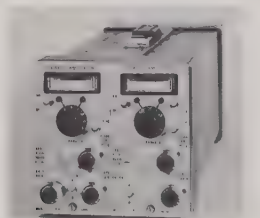
Model 11 GSLV
Tape and galvo
$815.00

Model 11MGSLV
Tape, galvo, meter
$865.00

Log amp series compresses 1000:1 input signal variation to 4:1 output signal variation. Waveform and frequency content of output is same as input. When combined with companion DADC-5, direct measurement of transmissibility can be made down to 5 Hz.

OPTIONAL FEATURES

T	Matched performance and use with Tracking Filter	$200.00
O	1 kHz Internal Calibration Oscillator — fixed amplitude, sine wave	$50.00
F	Floating DC output for amplifiers supplied with meters	$25.00
—8	Large Meter (2½ inch scale) with 8¾ panel height	$20.00



MODEL 11P-2
Dual Channel Portable Adapter
with 2 channels of Model 11 series
Model 11P-2 **$70.00**

MODEL 11 SERIES
With -8 option

MODEL 11R
Rack Frame Adapter
with 6 channels of Model 11MGA
Model 11R **$200.00**
Blank Panel **$7.50**

cers for driving tape and galvo recorders

ECONOMY MODEL V11 AMPLIFIERS FOR USE WITH REMOTE CHARGE OR VOLTAGE PREAMPLIFIER

The Model V11 amplifier is a lower cost instrument that deletes the charge input stage of the standard Model 11 series and uses a remote preamplifier for conversion of the transducer output to a low impedance signal. The remote preamplifier can be selected as either the Model 11CA-2 charge input type or the Model 11PA-2 voltage input type. The Model V11 amplifier has screw driver adjustment for the tape and galvo outputs, a 2 position calibrate switch, Option I full scale ranging, and deletes the switchable filter feature. **V11MS $445.00**

V11GS $465.00

V11MGS $510.00

MODEL 11CA-2 REMOTE CHARGE PREAMP

When connected to any Series 11 amplifier, this low noise remote charge preamplifier eliminates cable noise and provides a 1 mV/pC conversion gain. The less than 50 ohm output impedance drives up to 2000 feet of standard RG/U coaxial cable. The unit is packaged as a BNC to Microdot type adapter. **$80.00**

MODEL 11PA-2 REMOTE VOLTAGE PREAMP

When connected to any Series 11 amplifier, this remote voltage preamplifier provides 1000 megohm input impedance, less than 50 ohm output impedance, and unity gain. This preamplifier is particularly suitable for use with "voltage" type piezoelectric transducers and is compatible with both resistive and capacitive type transducers. The low output impedance eliminates cable noise problems and will drive up to 2,000 feet of standard RG/U coaxial cable. The unit is packaged as a BNC to Microdot type adapter. **$50.00**

MECHANICAL IMPEDANCE & TRANSMISSIBILITY ACCESSORIES

These basic building block components permit automatic plotting of mechanical impedance, transmissibility, or the ratio of two complex quantities. The frequency range of 5 Hz to 20 KHz is covered with a dynamic range capability of up to 120dB. Each instrument contains its own power supply and can be used as a separate, portable unit when not mounted in the Model 11R Rack Frame Adapter.

MODEL 11MGSL	MODEL 11MGSL	MODEL DADC-5	MODEL LFC-5	MODEL MAC-2	MODEL MC-10

Model 11MGSL
Any of the log type charge amplifiers, with the options described on page 4, eliminate the need for 2 separate log converters and fulfill a wide range of signal conditioning requirements.

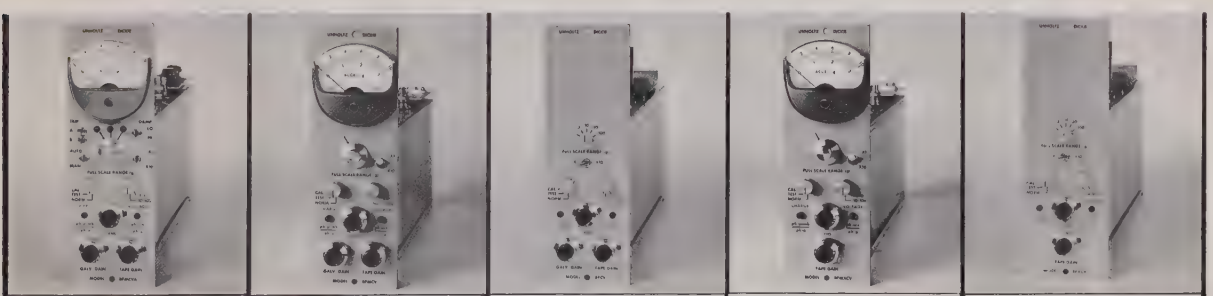
Model DADC-5
Differential AC-DC Converter. DC output represents ratio of the two measured quantities. $1,400.00

Model LFC-5
Log Frequency Converter. DC output represents logarithm of input frequency. $750.00

Model MAC-2
Averaging Control. Permits control to weighted average of measured quantities. $650.00

Model MC-10
Mass Compensator. Compensates for component of measured force used to drive head of force transducer. $495.00

608 SERIES CHARGE AND VOLTAGE WITH COMMON POWER SUPPLY



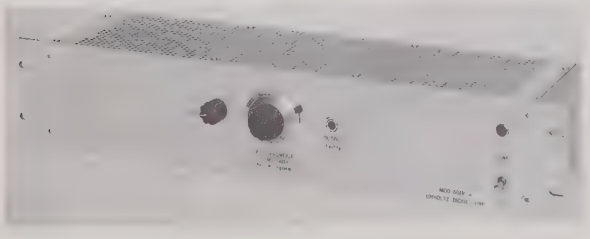
8PMCVA Auto-Ranger	8PMCV	8PCV	8PMXCV	8PXCV
Automatic Ranging				
Meter	Meter		Meter	
Galvo output	Galvo output	Galvo output		
Tape and servo output	Tape and servo output	Tape and servo output	Tape and servo output	Tape and servo output
$655.00	$485.00	$425.00	$415.00	$355.00

608PS-1 PORTABLE POWER SUPPLY WITH PLUG-IN MODULES Accepts up to two modules in any combination
608PS-1 $410.00

608R POWER SUPPLY AND RACK FRAME ADAPTER WITH PLUG-IN MODULES Accepts up to 6 modules in any combination
608R $540.00

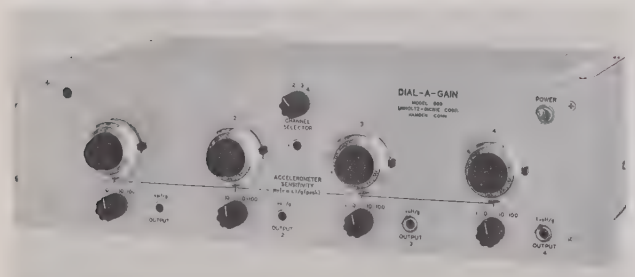
DIAL-A-GAIN SERIES VOLTAGE AMPLIFIERS

MODEL 601 **$225.00**
General purpose portable instrument for measurement of acceleration. Convenient 1 V rms/g pk and 10 mV/g outputs for readout on oscilloscope or voltmeter. .01 g to 100 g without range switching. Direct dialing of any accelerometer sensitivity from 1 to 100 mV rms/g pk

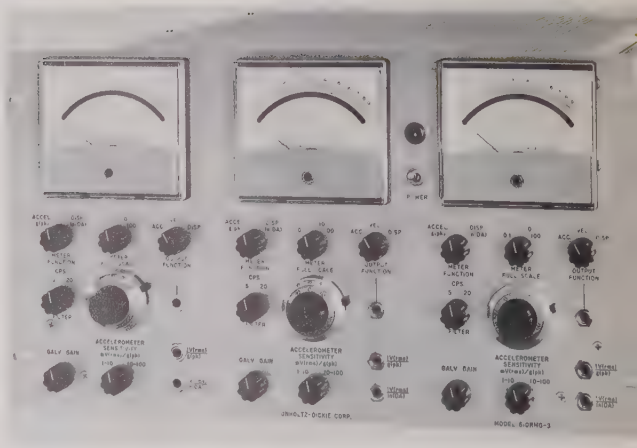


MODEL 601R-A **$260.00**
Rack mounted version particularly suited for exciter system servo control. Operation with the Model 20D21 accelerometer provides excellent low level displacement control down to 5 Hz.

MODEL 602 **$375.00**
MODEL 602R (rack mount) **$410.00**
2 channel version. Front panel switch selects either channel for easy monitoring or comparison on external voltmeter

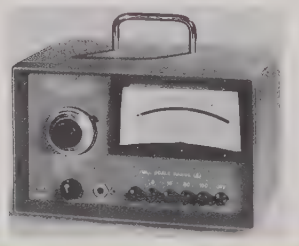


MODEL 603R **$695.00**
Low cost 4-channel instrument



MODEL 610RMG-3 **$2,150.00**
This versatile vibration monitoring instrument combines double integrating features with high current outputs for driving high frequency galvanometers. Acceleration outputs normalized at 1 V rms/g pk and 10 mV/g in addition to full scale ranging at 1, 10, 100 g. Velocity output at 96.3 mV/in/sec. Displacement output normalized at 1 V/in DA and full scale ranged at .1, 1, 10 in. DA. Galvo output adjustable from 0 to 10 V pk full scale level. Large, accurate logarithmic meters indicate acceleration or displacement. Driven shield input with 25′ triaxial cable supplied for each of the three channels.

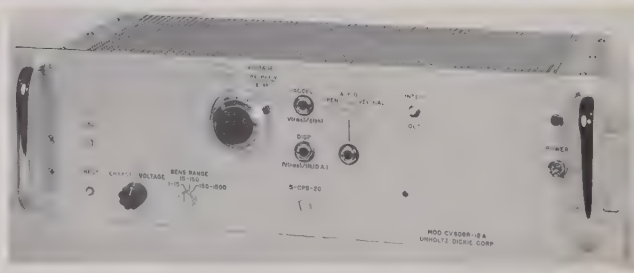
MODEL 610RM **$730.00**
Single channel, rack mounted, double integrating, no galvo output



MODEL 606M **$395.00**
MODEL 606RM (rack mount) **$430.00**
Same as Model 601 with integral meter and full scale ranges of 1, 3, 10, 30 and 100 g

MODEL V608R-12A **$975.00**

Reference accelerometer is connected to one V or CV standardizer and unknown accelerometer is connected to a second V or CV standardizer. When outputs are adjusted equal, the sensitivity of the unknown accelerometer is read directly on the precision sensitivity dial of the unknown channel. This procedure is applicable to accelerometers, velocity pickups, or other transducers, since these double integrating instruments have acceleration, velocity, and displacement outputs. Acceleration frequency response is within ±0.5% from 10 Hz to 10 KHz (since both channels are matched this error virtually disappears). Velocity response is ±1%, 10 Hz to 2 KHz. Displacement response is ±1.5%, 10 Hz to 70 Hz.



MODEL CV608R-12A **$1,500.00**

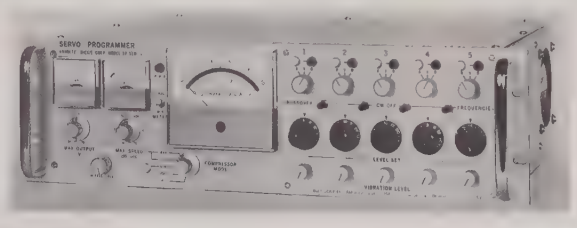
ACCESSORY INSTRUMENTS
for control and protective functions

MODEL AFP SERIES
ARBITRARY FUNCTION PROGRAMMER

- Curve follower programs arbitrary function of acceleration vs. frequency
- 50 dB amplitude range
- 3 decade frequency range
- Controls average or largest of several accelerations to program
- Use with MAC-6C or ATC-6

Model AFP-1 **$3,475.00**
(Use with SP-1M, SP-2 and SP-5 servo and MAC-6C)

Model AFP-6 **$4,950.00**
(Use with ATC-6 and BK 1025)



SERVO PROGRAMMERS

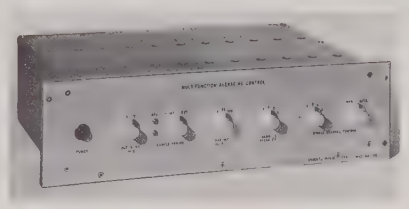
Features: Combines functions of amplitude servo and vibration programmer in one instrument ■ Programmer contains up to five program segments with servo controlled acceleration, velocity, or displacement selectable for each segment (SP5) ■ Simplified closed-loop presetting of vibration levels before actual test is performed ■ Solid state, plug-in, printed circuit construction ■ Analog output for recording levels.

MODEL SP-5 (5 segment programmer) **$4,330.00**
MODEL SP-2 (2 segment programmer) **$2,330.00**
MODEL SP-1M (servo only, vibration meter) **$1,750.00**

MODEL AP-5
AUTOMATIC PROGRAMMER FOR BK SERVOS

- Up to five programmed vibration levels
- Any combination of displacement and acceleration in sequence
- Any combination of velocity and acceleration in sequence
- Amplitude settings with 100 to 1 range
- Direct vibration reading on BK 1039 or BK 1025 at all times
- Complete independence of amplitude and transfer frequency controls
- Pilot lights indicate mode of operation at all times
- Programmed control can be switched out for normal operation
- Size 19" wide x 5¼" high

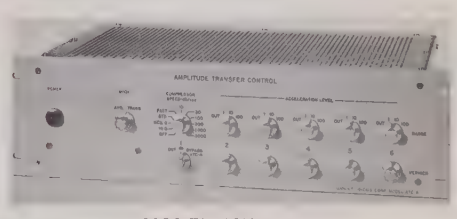
Model AP-5 (including rework of BK) **$2,000.00**



MODEL MAC-6C
MULTIFUNCTION AVERAGING CONTROL

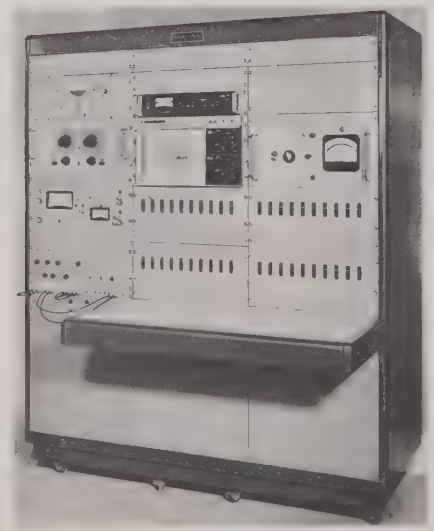
Features: Phase insensitive averaging for at least 6 inputs • Allows averaged shaker system control for sine and random tests • Sine tests: absolute average of output yields average of input magnitudes • Random tests: spectral density of output yields average of input spectral densities • Freedom from detector time constant problems. • 2 or more units can be coupled • Analog DC output
Model MAC-6C **$1,850.00**

Model MAC-2. Two channel unit in model 11 modular case. Increases dynamic range of impedance system by controlling to weighted average of force and acceleration.
Model MAC-2 **$650.00**



MODEL ATC-6
AMPLITUDE TRANSFER OR AVERAGE CONTROL

Features: Dual function instrument provides control of sine tests from highest of up to six acceleration inputs or from their average • Transfer mode maintains acceleration of each input at or below individually pre-set levels • Negligible overshoot when control transfers from one channel to another • Average mode provides control from phase-insensitive average of input accelerations • 2 or more units can be coupled • Operates with BK 1039 and BK 1025 only
Model ATC-6 **$2,400.00**



RV500B RANDOM NARROW BAND EQUALIZER AND RECORDING ANALYZER

Complete Random Control Center for use with any sine shaker system. Equalizer section includes noise generator, spectrum shaping filter, shaker equalizer, forty channel specimen equalizer, adjustable acceleration level clipper and provisions for mixing sine and random. Analyzer section includes true rms voltmeter, sweeping narrow band analyzer with switchable filters, and log converter and plotter for recording spectral density vs frequency. Analyzer may also be used as random reject filter for conducting servo controlled combined sine-random tests. Patch panel allows use of analyzer as a tracking filter during sine tests.

MODEL E105
SPECTRUM SHAPER

- Simple economical method of converting sine shaker systems for random testing with small specimens
- Fourteen band-pass filters covering the frequency range from 20 cps to 2KC with independent amplitude control allows flattening the shaker-specimen frequency response
- Typical systems with light specimens can be adjusted within ±1½ db of a flat response
- Also includes provisions for shaping the spectrum (other than flat) as required by some specs
- Provisions for mixing sine and random signals

Model E105 (14 channels) **$1,750.00**

ACCELEROMETERS

MODEL		VOLTAGE SENS. mV pk/g pk	CHARGE SENS. pk PCMB/g pk	CAPACITANCE PF	MOUNTED RESONANT FREQ.	SIZE WEIGHT in - grams	DESIGN TYPE	CRYSTAL MATERIAL	PRICE
*2E3 *2E5	Subminiature, extremely small, lightweight for highest frequencies or minimum added mass. 2E5 has wrenching flats for removal.	2.5	1.0	380	70 KHz	.225 Dia. x .225 Ht. .065 grams	Shear Integral Cable Adhesive Mount	PZT.	$213.00
*5D21-8	General purpose. Relatively small with moderately high resonance. Recommended for charge use.	4.0	8.0	2000	40 KHz	.50 Hex. x .64 Ht. 13 grams	Shear Top Connector 10-32 Mtg. hole	PZT.	$185.00
*5D21	Similar to 5D21-8. Recommended for voltage use.	6.5	12.0	2000	40 KHz				
*10D21	Similar to 5D21 with slightly increased sensitivity. Recommended for voltage use.	9	13.0	1400	35 KHz				
*10DQ21	General purpose with side connecting cable for restricted height applications.	20	40	2000	30 KHz	.62 Hex. x .71 Ht. 25 grams	Shear Side Connector 10-32 Mtg. hole	PZT.	$185.00
*5D41	High internal capacitance for direct connection to a scope or VTVM.	7.5	75	10000	30 KHz	.62 Hex. x .71 Ht. 25 grams	Shear Top Connector 10-32 Mtg. hole	PZT.	$213.00
*20D21	General purpose. Recommended for voltage use when 35 foot or longer accelerometer low noise cable is used.	20	30	1500	30 KHz				$185.00
*25D21	Similar to 20D21. Recommended for voltage use when 50 foot or longer accelerometer low noise cable is used.	27	38	1400	30 KHz				
*13D6B	Approximately flat voltage and charge sensitivity vs frequency from 5 Hz to 5 KHz	13	5	375	30 KHz				$200.00
*75D21	Maximum voltage and charge sensitivity gives best signal/noise ratios for very low level vibration measurements.	70	70	1000	20 KHz	.75 Hex. x .70 Ht. 37 grams			$185.00
8B6	Wide temperature range —300° to +500° F. Approximately flat voltage and charge sensitivity vs frequency from 5 Hz to 5 KHz.	3.3	8.0	2400	30 KHz	.76 Dia. x .88 Ht. 36 grams	Compression Double Base Top Connector 10-32 Mtg. hole	Bismuth Strontium Titanate	$220.00
8Q10	Quartz precise calibration standard. Designed to be used as NBS Calibrated Standard. Minimum variation in sensitivity with temperature, approximately flat voltage and charge sensitivity vs frequency.	9.0	2.0	225	30 KHz			Quartz	$310.00

*Shear type piezoelectric construction for least base or case strain and cable motion response to external inputs.

Request quantity discount schedule

Some instruments available for 220 volt, 50 cycle, packed for export at 7.5% extra; check with factory.

Specifications and prices subject to change without noti

manufacturers of shaker systems, advanced instrumentation, and accelerometers

UNHOLTZ-DICKIE CORPORATION

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Bulletin No. IB 3/68 35M

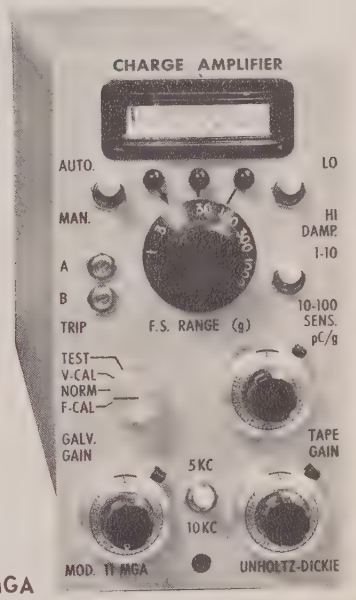
UNHOLTZ-DICKIE CORPORATION

vibration generation systems and measurement instruments

CHARGE AMPLIFIER

FOR RECORDING 100 MICRO "g" TO 10,000 "g"

How would you measure 100 micro "g"? This is the challenge that led to the development of the Series 11 Charge Converters and Signal Conditioning Amplifiers. Measurement of such threshold accelerations required an amplifier design which minimized all sources of unwanted signals. Elimination of ground loops with line isolated individual power supplies, utilization of the newest low noise FET's and limiting bandwidth with built-in filters has yielded the first micro "g" instrument. Even if your application doesn't require monitoring low "g" levels why not enjoy the luxury of freedom from ground loops and optimized signal to noise ratio on your next test?



MODEL 11MGA

EXCLUSIVE UNHOLTZ-DICKIE FEATURES

AUTO-RANGING AND COMPANION RANGE RESTORER OR **AC LOG CONVERSION**

INDIVIDUAL DOUBLE SHIELDED POWER SUPPLY

- Line Isolated
- Ground Loops Eliminated
- Portable

CHOICE OF OUTPUTS

- Tape Recorder Driver (ADJ. 0-5V)
- Galvanometer Driver (ADJ. 0-5V)
- Normalized Servo Control Signal

HIGH GAIN

- Standard full scale output with sensitivities of 1 to 100 pC/g
- Optional Full Scale of .01 g

FREQUENCY RANGE

- 2 Hz to 100 K Hz

SELF CALIBRATING SENSITIVITY DIAL

- Originated by Unholtz-Dickie Corp.

FILTERS

- Any 2 bands selectable
- Eliminate unwanted signals and noise

ALL SILICON CIRCUITRY

- Minimum Noise
- Minimum Heat Load

ULTRA LOW NOISE

- Less than 0.1% of full scale under typical conditions

CALIBRATION MODE

- 3 Modes available
- Full scale output independent of front panel controls
- Optional internal or external oscillator

MINIMUM SIZE

- Printed circuit construction
- Panel height 5 1/4"

GENERAL DESCRIPTION

The Series 11 Amplifiers are completely self contained signal conditioning charge amplifiers for use with piezoelectric transducers. Cable lengths up to 1 mile may be used between the transducer and the amplifier. The Series 11 convert a charge signal to a voltage signal and amplify the voltage signal to the levels required for driving recorders and for meter indication. Various optional outputs are available. Each Amplifier includes a gain control calibrated in terms of transducer charge sensitivity units which adjusts the overall gain to provide full scale outputs for any transducer sensitivity between 1 picocoulomb/unit and 100 picocoulomb/unit. At maximum gain, full output is obtained for an input signal of 1 picocoulomb, except for Option III which provides full output with 0.1 pC input.

GROUND LOOP problems are eliminated by the use of individual double shielded power supplies in each amplifier providing line isolation comparable to that obtained with battery supplies. In large multichannel installations, the amplifier outputs are tied to a recorder or recorders with a common ground. For minimum ground loop difficulties, this should be the only interconnection between channels. If a group of amplifiers share one large power supply, then the signal common leads are tied together at the amplifiers as well as at the recorders providing potential ground loops. These loops exist even if the power supply is ungrounded.

Individual supplies provide the further advantage of portability and are convenient for use as single units.

NOISE

Extremely low threshold noise has been achieved in the design of this instrument by utilizing a combination of techniques including all solid state circuitry, double shielded power supplies, and band limiting filters. Solid state circuits eliminate microphonic type noise. Double shielded power supplies provide isolation from the power line and prevent ground loops. The remaining threshold noise is mainly broad-band transistor noise. The built-in low pass filters limit this broad-band noise to the frequency range of interest.

OUTPUTS

Any combination of four outputs available.

- Tape driving amplifier provides a full scale voltage output of ±5 volts peak at 1 ma. It is continuously adjustable from 0 to maximum.
- Current amplifier for driving galvometers or long lines provides ±85 ma or ±5V to loads over 10 ohms. Output is continuously adjustable from 0 to maximum, current limited at ±100 ma for galvanometer protection.
- Meter with 1.24 inch scale calibrated in percent of full scale
  Optional meter with two scales 0-1 and 0-3
- Servo control output at 10 mv/g (or other optional levels) independent of range switch settings

RANGES

The standard instrument has a maximum transfer gain of 5 V/pC. This can be extended to 50 V/pC for applications requiring very low level measurements provided the input cable length is limited to 125 ft. as described in Option III.

Since less gain is required for high sensitivity accelerometers, the full scale range switch can have two scales, one for sensitivities 1-10 and the other for 10-100. This arrangement available as Option II provides an additional low range for high sensitivity accelerometers, but has the disad-

RANGES (Continued)

vantage of requiring the operator to remember the sensitivity when interpreting the full scale range switch settings. The standard ranging method (Option I) separates the full scale ranging function from the sensitivity ranging function and allows the use of a single unambiguous scale on the range switch.

Option I (Standard as pictured)

Full scale output for any transducer from 1 to 100 pC/g. Range switch settings are not dependent on transducer sensitivity and full output at 1 g is available with low sensitivity accelerometers. Seven ranges in 1, 3, 10 steps to 1000 g are standard. Range steps of 1, 2, 5, 10, etc. are available at slight additional cost. Note that use of low sensitivity accelerometers on the 10-100 range provides full scale range of 10,000 g.

Option II

Dual scale range switch provides 9 ranges in 1, 3, 10 steps to 10,000 g for transducer sensitivities of 1 to 10 pC/g. Second scale provides 9 ranges from 0.1 g to 1000 g for transducer sensitivities of 10-100 pC/g.

Option III (For low level measurements)

Dual scale range switch provides 9 ranges in 0.1, 0.3, 1.0 steps to 1000 g for transducer sensitivities of 1 to 10 pC/g. Second scale provides 9 ranges from .01 to 100 g for transducer sensitivities of 10-100 pC/g.

FILTERS

Low pass filters are included in the amplifier to limit the broad-band instrument noise and also to reject input signals outside the desired passband. Choice of two upper frequency limits are switch selectable on the front panel. Frequency response is flat within 2% to the indicated frequency.

CALIBRATION of the charge amplifiers and of the recording system and testing continuity of the input transducer and cable can be performed from front panel controls. Insertion of a known voltage signal at the input of the amplifier just prior to recording provides two functions: (a) Checking that the amplifier is operational and (b) Providing a full scale signal at the output. The output amplifier gain may then be adjusted to the desired recording level. The input calibrating signal may be obtained from an external oscillator or an optional internal oscillator. The standard instrument includes a rear input for permanent connection to an external oscillator. A front panel switch marked "Test", "V-Cal", "Norm" and "F Cal" selects the desired calibrate mode.

The "F Cal" Mode connects the calibrating signal to the input and provides full scale output for a 100 mv input independent of the sensitivity dial or range switch settings. In this mode, all channels have the same output and recording levels can be adjusted.

The "V Cal" Mode provides an output dependent on the sensitivity dial and range switch settings, thereby allowing checking the functioning of these components.

The "Test" Mode inserts the calibrating signal in series with the accelerometer cable shield. The output voltage is then proportional to the cable and accelerometer capacitance. An open or short is quickly detected.

PORTABILITY is an advantage of self contained power supplies. Amplifiers may be rack mounted in groups of six or removed and used singly at remote test sites. If an amplifier malfunctions or requires calibration, it can be serviced or sent to calibration without requiring a large separate power supply.

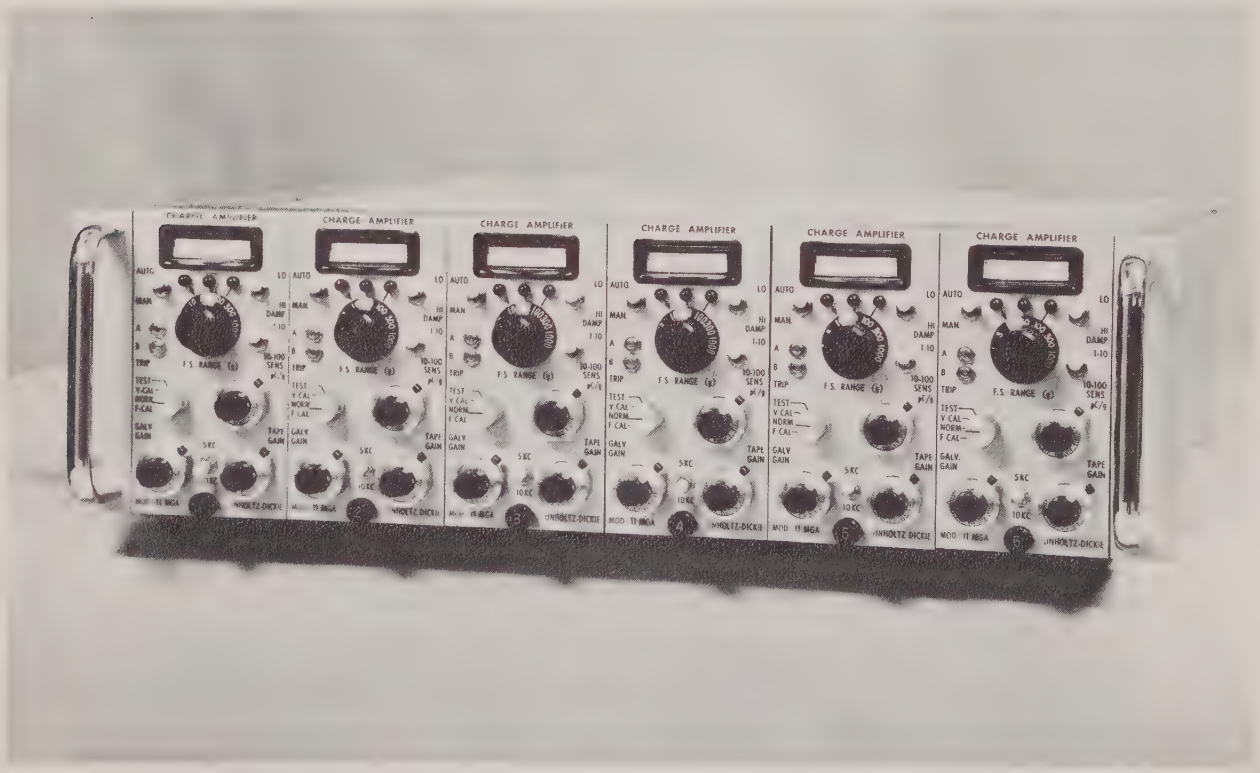
AUTO-RANGING WITH RANGE RESTORER OR LOG CONVERSION

The dynamic range of these instruments is exceptional, with the noise level approximately 60 db down on all except the lowest ranges. However, the dynamic range of most recorders is limited to 20 to 40 db depending on the tolerable signal to noise ratio.

Many dynamic tests result in data with large amplitude variations. Transmissibility plots are typical examples. In order to avoid saturating the recorder, some means of compressing the data is desirable. Unholtz-Dickie Corporation has pioneered two solutions to this problem, Auto-Ranging and Log Compression. Either arrangement is available as an option in the Series 11 Charge Amplifiers and detail specifications are listed in a separate bulletin.

Auto-Ranging is available with a coding signal to indicate range changes. An automatic decoder for use on playback restores the original dynamic range.

A logarithmic converting output amplifier is available whose gain is proportional to the log of the average input signal. The output is an AC signal of the same shape and frequency content as the input. Its average value is proportional to the log of the average value of the input.



6 CHANNELS OF MODEL 11MGA CHARGE AMPLIFIERS
MOUNTED IN MODEL 11R RACK FRAME ASSEMBLY

SERIES 11 CHARGE AMPLIFIER SPECIFICATIONS

Input Characteristics

Source Impedance: Capacitive shunted by 50 megohm resistance or greater.

Input: Single ended with one side connected to signal common.

Overload Recovery Time: Instantaneous for a 1 millisec pulse of 10,000 pC for accelerometers 1-10 pC/g and for a pulse of 100,000 pC for accelerometers 10-100 pC/g. (Ranging Option I)

Effect of Source Capacitance on Gain:

Range Switching Option	Range Switch Settings	Source Cap in pF	Gain Change
I	1-10 Sens R, any FSR	50,000	< 1%
	10-100 Sens R, any FSR	50,000	< .1%
II	Lowest 5 FS Ranges	50,000	< 1%
	Other FS Ranges	50,000	< .1%
III	Lowest 5 FS Ranges	5,000	< 1%
	Other FS Ranges	50,000	< 1%

Outputs

Tape Driver: ±5V peak into 5k ohm load or greater adjustable 0 to 5V with 10 turn locking potentiometer. Output impedance less than 50 ohm in series with 100 microfarad capacitor.

Galvanometer Driver: (Optional) ±5V or ±85 mA, whichever is limiting to load resistances of 10 ohm or greater. Current limited at ±100 mA. Adjustable 0 to max with ten turn locking potentiometer. Output impedance less than 1.5 ohm (direct coupled). Short circuit protected.

Integral Meter: (Optional) 1.24 inch scale meter calibrated in percent of full scale; 2% accuracy full scale; average detector. Optional 2 scale meter calibrated 0-10 and 0-3.

Servo Output: (Optional) Normalized to 10 pk mV/pk g independent of full scale range switch for standard Option I ranging. Useable to 100 g full scale with Option II ranging.

Noise

Range Switch Option I

Less than .005 pC rms plus .003 pC rms/1000 pF source capacitance, referred to the input, for accelerometers 1-10 pC/g and .05 pC rms plus .004 pC rms/1000 pF source capacitance, referred to the input, for accelerometers 10-100 pC/g or 5 mV rms referred to the output whichever is greater for 10 kHz filter bandwidth.

Range Switch Option II

Less than .005 pC rms plus .003 pC rms/1000 pF of source capacitance, referred to the input, for the lowest 5 ranges or 5 mV referred to the output whichever is greater for 10 kHz filter. Less than .05 pC rms plus .004 pC rms/1000 pF, referred to the input, for the upper four ranges or 5 mV referred to the output.

Noise (Continued)

Range Switch Option III

Less than .002 pC rms plus .003 pC rms/1000 pF source capacitance referred to the input for the lowest 5 ranges or 5 mV rms referred to the output.

Ranges

Option	Sens.	Full Scale Range (g) .01	.03	.1	.3	1	3	10	30	100	300	1000	3000	10000
I	1-10					←						→		
	10-100			←								→		
II	1-10					←								→
	10-100			←								→		
III	1-10			←								→		
	10-100	←								→				

NOTE: Option I allows use of transducer sensitivities of 1-10 on the 10-100 range to provide full scale output of 10,000 g, or transducer sensitivities of 10-100 on the 1-10 range to provide full scale output of 0.1 g.

Meter Accuracy

±2% of full scale on any range at 1 kHz

Frequency Response

Tape Driver Amplifier with no filter
±5% 2 Hz to 30 kHz
±1% 10 Hz to 15 kHz
3 dB down at 100 kHz with 1000 pF source capacitance and any range setting, or 50,000 pF with 10-100 Sen and any FSR

Galv. Driver Amplifier with no filter
±5% 2 Hz to 20 kHz
±1% 10 Hz to 10 kHz

Amplitude Linearity

1% of best straight line

Stability

±0.25% for line variation 105 to 125 V AC
±2% for time and temperature variations

Harmonic Distortion

Less than 0.5%

Warm Up

15 minutes

Low Pass Filters

Two filter frequencies switchable on front panel. Standard frequencies are 5 kHz and 10 kHz, and attenuation rate is 18 dB/octave.

Filter design is essentially Butterworth. Frequency response ±2% at specified filter frequency and approximately 3 dB down at twice the specified filter frequency (zero source capacitance). Phase response is approximately 60° at specified filter frequency and 135° at twice the specified filter frequency.

Options: Selection of other than standard switchable frequencies from 100 Hz to 20 kHz, or selectable plug-in filters.

Phase coherence can be held to $\pm 2^{\circ}$ of best straight line for theoretical Butterworth filter.

Calibration

Provisions for insertion of calibration voltage through 1/2% charge converting capacitance. Four modes selectable by front panel switch. Rear connections for external calibration signal.

F-CAL: Provides full scale output for 100 mV peak input independent of range or sensitivity setting.

V-CAL: Connects calibration signal as simulated accelerometer output such that for a calibration input of 10 mV the amplifier output will be the same as when an accelerometer generating 10 pC is connected to the input within ±0.5%.

TEST: Connects calibration signal in series with common side of input cable.

NORMAL: Calibration signal disconnected – Operate Mode

Option: 1. Calibration sine oscillator with ±1% amplitude stability at 1 kHz provides 100 mV peak output. One master channel can supply signal for up to 6 modules in rack frame.

Option: 2. Selection of calibration modes by internal relays and remote command signals.

Power Supply

Individual power supply included in each module. Double shielded transformer with less than 1 pF capacitance and more than 10 megohm resistance between primary and secondary.

Voltage: 105 to 125V AC, 60 Hz
Current: 0.15 amp rms
Transients: Amplifier output transient less than 5 mV/V line transient.

Physical Specifications

Finish: Light grey front panel. Totally enclosed module with durable vinyl clad finish makes each channel completely portable. Plug-in power connector mates with rack frame power strip or individual line cord.

Dimensions: 5 1/4'' high x 2 13/16'' wide x 19'' deep (single channel portable)
5 1/4'' high x 19'' wide x 19 1/2'' deep (6 channel rack mount)

Mounting: Amplifiers arranged for mounting in Model 11R Rack Adapter, in two or three channel portable adapters, or as individual bench mounted units.

Connectors:

Accelerometer Input	– BNC. This can be converted for use with low noise Microdot type cable with a Microdot 33-101 Adapter furnished by purchaser.
Oscillator Input	– Miniature phone jack
Voltage Out (TAPE)	– BNC
Optional Current Out (GALVO)	– BNC
Optional Servo Out (10 mV/g)	– BNC

Panel Controls:

Sensitivity Dial	– 10 turn 0.25% linearity potentiometer with calibrated locking dial. Two position Sens. range toggle switch with FSR Option I.
Full Scale Range	– Seven position rotary switch with FSR Option I Nine position rotary switch with FSR Option II & III
Voltage Out (TAPE)	– 10 turn potentiometer with numerical indicating, locking dial
Current Out (GALVO)	– 10 turn potentiometer with numerical indicating, locking dial
Calibration	– 4 position rotary switch
Filter Selector	– 2 position toggle switch

Weight:

Individual Module	– 5.5 lb. with all optional features

Physical Specifications (Continued)

Temperature:	+40°F to 125°F operating –65°F to 185°F storage
Humidity:	95%

SERIES 11 AMPLIFIERS

Model 11

Basic charge amplifier with tape driver amplifier (Voltage Output) and integral power supply. This model available with any combination of features listed.

Additional Features

Suffix G . . . . . Galvanometer Driver
M . . . . . Meter
S . . . . . Servo
O . . . . . Internal Calibration Oscillator
A . . . . . Auto-Ranging (See separate bulletin)*
L . . . . . Log Output (See separate bulletin)*
* A or L but not both

Example: 11MGA is a complete single channel amplifier with Tape and Galvanometer Driver Outputs, Meter and Auto-Ranging.

Model 11R

Rack frame holds up to 6 each of any combination of Series 11 Amplifiers. Rugged, open frame construction permits convection cooling. Convenient plug-in power strip with single line cord for 6 channels. Miniature patch cables for common calibration signal. Weight complete with 6 modules is 37 lbs.

Model 11P-2

Two channel carrying adapter. Weight complete with 2 modules is 11 lbs.

Accessories

Blank Panels
Individual Amplifier Power Cord

UNHOLTZ-DICKIE CORPORATION

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vibration generation systems and measurement instruments

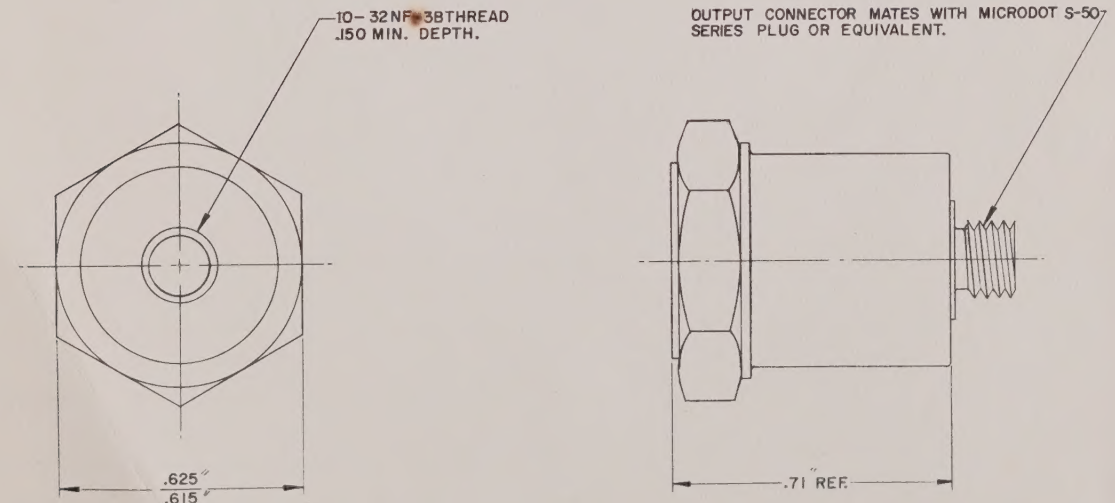
PIEZOELECTRIC ACCELEROMETER GENERAL PURPOSE MODEL 25D21

The Model 25D21 combines a good voltage output with a wide frequency range in a medium size case. The crystal is used in the shear-mode design, well known to be superior for case and base insensitivity. The shear-mode design also affords the best cross axis sensitivity of any type.

MODEL 25D21

MAIN FEATURES

Voltage Sensitivity: 25 mV pk/g pk, open circuit
Accelerometer Capacitance: 1300 pF
Crystal: Shear-type, lead zirconate-titanate
Mounted Resonance Frequency: 30,000 Hz
Low Base Strain and Cross Axis Sensitivity
Case Insensitive: No cable whip or thermal shock problems
Temperature Range: -165°F to +325°F



CALIBRATIONS

Each accelerometer is calibrated for voltage and charge sensitivity versus frequency by the comparison method from an NBS traceable reference accelerometer. Capacitance, resistance, cross axis sensitivity are also measured on each unit. Every unit is checked for case sensitivity.

PIEZOELECTRIC ACCELEROMETER GENERAL PURPOSE MODEL 25D21
SPECIFICATIONS

Electrical	
Voltage Sensitivity, open circuit - mV pk/g pk	25
Voltage Sensitivity, with recommended load – mV pk/g pk	17
(Recommended external load, capacitance pF)	(650)
Accelerometer Internal Capacitance – pF	1300 pF
Charge Sensitivity – pC pk/g pk	33
Mounted Resonance Freq.– Hz	30,000
Cross Axis Sensitivity, maximum (at 200 Hz)	3%
Accelerometer Resistance	
Room Temp. – Megohms	20,000
+350°F – Megohms	500
Frequency Response, volt. sens., ±5% var., 400 meg. load	0.7 Hz to 6 kHz
Amplitude Linearity	
Percent	2%
Range	2000 g

Mechanical		
Design Type – shear type, grounded case		Top Connector
Crystal Material (See note 5)		Clevite PZT®
Size:		.62 Hex .71 Ht.
Weight:	Ounces	0.9 ozs.
	Grams	25 grms.
Mounting		10-32 hole
Case Material		Stainless steel
Environmental		
Dynamic Range, g's:		
	Vibration	1000 g
	Shock	2000 g
Humidity, Sealing		Hermetic Grade A
Temperature Range for ± 2½% Volt. Sensitivity variation, with recommended ext. capacitance		-75°F to +225°F
Temperature Range for ± 5% Volt. Sensitivity variation, with recommended ext. capacitance		-165°F to +325°F
Base Strain Sensitivity, equivalent g's per 100 microinch strain		1 g maximum

NOTES:

1. Charge sensitivity variation vs. temperature:
   ±10% variation of sensitivity about room temperature value is obtained over temperature range -65°F to +200°F; ±5% variation over temperature range 0°F to 165°F. (Note: No series capacitance compensation included.)
2. Charge sensitivity vs. frequency:
   Approximately 2.4% drop in sensitivity per decade of frequency from .1 Hz up, inherent characteristics of crystal accelerometer material.
3. Capacitance change vs. frequency:
   Approximately 2.4% drop in capacitance per decade of frequency from .1 Hz up, inherent characteristics of crystal accelerometer material.
4. Thermal shock:
   For a 50°F step function in temperature applied to the case of the accelerometer, less than 1 equivalent 'g' output signal obtained.
5. Crystal Material: Clevite Corp. PZT®, a lead zirconate-titanate ceramic composition with a Curie Point temperature of 365°C.
6. Accoustic Sensitivity less than .1 g rms at 100 dB broadband.
7. Altitude – Not affected.

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